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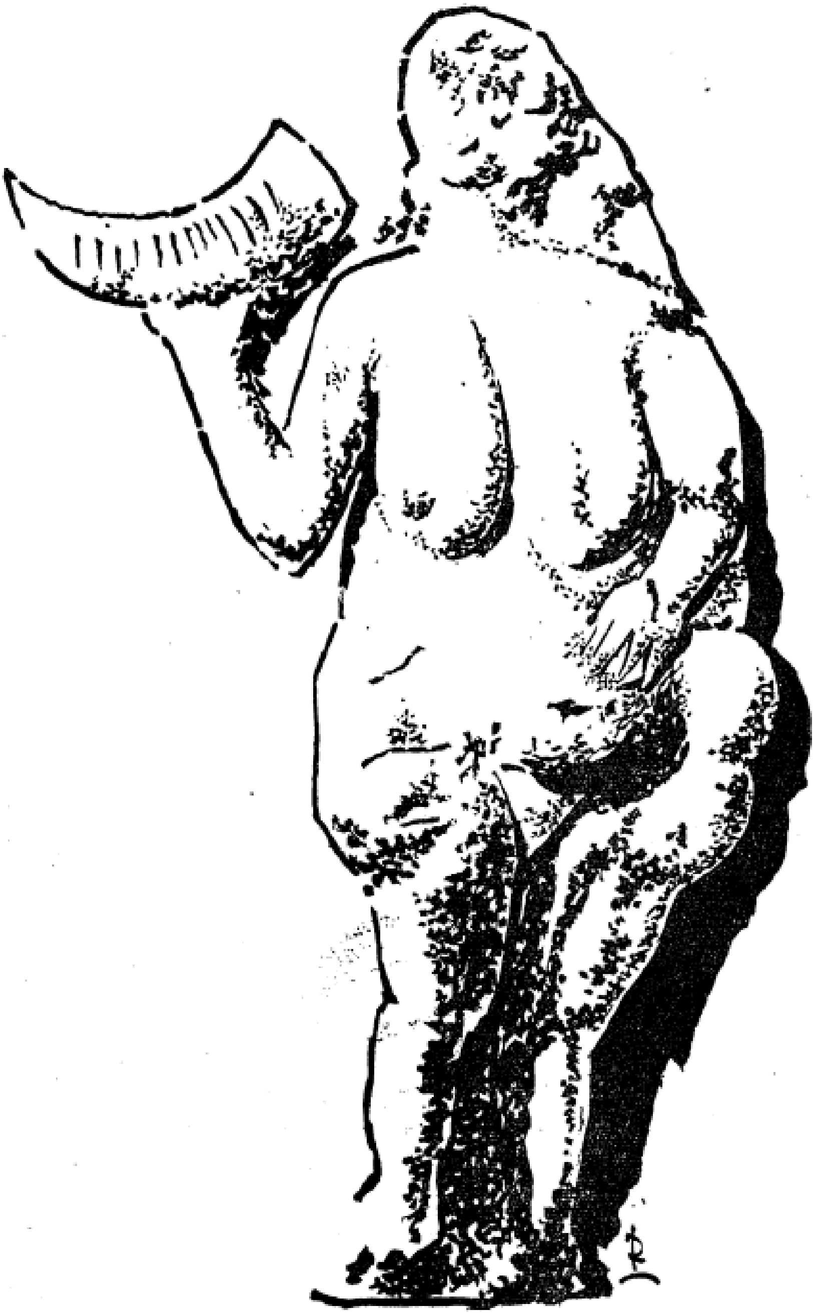

Mother Goddess of the Laussal Cave, c. 19000 B. C.

Monograph No. 1.

PREHISTORIC LUNAR ASTRONOMY

"The hymns are written in the high heavens :
what shall he do with the earthly hymns —
he, who cannot read those heavenly ones?"
—Dirghatama (c. 2350 B.C.)

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PREHISTORIC LUNAR ASTRONOMY

19000 — 3100 B.C.

Vasant Pancami, 1976

Monographs :

1. Prehistoric Lunar Astronomy, 19000 - 3100 B.C. ... Rs. 36/-
2. Ancient India, a chronological study, 1500-400 B.C .. Rs. 45/-

In preparation :

3. Chronological Infrastructure of Indian Protohistory, 3100-1300 B.C.
4. Vedic Astronomy, 3100-1300 B.C.
5. Days of the Upanishads.
6. Aryana, a global study in the protohistorical chronology of Iran, Afghanistan, Pakistan and North-western India.

and

7. Date of the Mahabharata battle, being a reply to the comments on the monograph No. 2.

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अवाप्ति संख्या ... दिनांक 23.8.79
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केन्द्रीय पुरातत्व पुस्तकालय

Printed at Bela Printers, New Delhi. Dated March, 1976

FOREWORD

Writing as early as 1974, a distinguished archaeologist had stated that archaeology was becoming increasingly dependent on a multitude of sciences, drawing upon physics, chemistry, geology, ecology, sociology, botany, etc. Little did he realise that astronomy was fast becoming another scientific aid for the solution of many problems of archaeology. Since 1950 or so, many articles using astronomical data for the solution of the archaeological and ethnological problems had been written in Europe ; a more recent one being by E. Baity on 'Archaeoastronomy and ethnoastronomy so far', published in the October 1973 issue of **Current Anthropology.** S. B. Roy made some very useful comments on this paper and has now written a substantial thesis incorporating his views.

I have carefully gone through his new book 'Prehistoric Lunar Astronomy'. It seeks to give an introduction to the new science of **ethnoastronomy** in which he is an authority. As the astronomical observations are self-dating, no student of anthropology, ethnology, archaeology or ancient history can afford to ignore the basic knowledge of how the ancient calendars were made. The book will equip them with this basic knowledge, and thus, will enable them to judge the validity and the range of errors of astronomical methods of dating. It will also enable them to to carry on independent research in ethnology and mythology, because most of the ancient myths, rituals and symbols have some astronomical significance. The method has however, its pitfalls, but the author has given precautions necessary to be taken in applying astronomical methods.

The book contains a number of useful tables, charts and an illustrative star map. Although written in a non-technical language, it is a strictly scientific exposition of the most ancient of the sciences.

The fascinating book merits a close study by all students interested in the Story of Man.

B. K. Thapar,
Joint Director General
Archaeological Survey of India.
New Delhi

Abbreviations :

R.V.	=	Rigveda.
T.S.	=	Taittiriya Samhita.
Yaj.	=	Shukla Yajurveda.
M. BH.	=	Mahabharata
Ved. Jyot.	=	Vedanga Jyotisha
Nir.	=	Nighantu and Nirukta by Yaska.

English :

AIHT	=	Ancient Indian Historical Tradition *by Pargiter.*
HASL	=	History of Ancient Sanskrit Literature *by Max Muller*
IHA	=	Introduction to Hindu Astronomy *by Bentley*
		and
AI	=	Ancient India, a chronological study, 1500-400 B.C. *by S.B. Roy, Delhi 1975*

Journals :

AR.	=	Asiatick Researches.
JRAS	=	Journal of the Royal Asiatic Society.
JAOS	=	Journal of the American Oriental Society.
IA	=	Indian Antiquary.
JBRS		Journal of the Bihar Research Society.
JARS	=	Journal of the Andhra Research Society.

SCOPE OF THE STUDY

SUBJECT

The subject of the study is the ancient lunar astronomy in all its aspects : All concepts and ideas — mythical, legendary, ritualistic, magical or scientific — which the ancients used to build up a system of knowledge of the heavens **on a lunar time base** forms the field of this investigation : In particular, the science of seasons (herein called **ritunomy**) will be as important as the celestial phenomena.

It is thus significantly different from the self chosen narrow field of Neugebauer[1] :— "We shall here call 'astronomy' only those parts of human interest in the celestial phenomena which are amenable to mathematical treatment. Cosmology, mythology, and applications to astrology must be distinguished as clearly separate problems".

Not only is Neugebauer's field of enquiry severely limited but a tacit assumption is also made though not stated. All mathematical analysis referred to above is made on a '**solar** time basis' which alone, according to Neugebauer, is 'scientific' astronomy: however, the time base now to be considered will be lunar instead of solar. The power, the depth as well as the shortcomings of the lunar method will disclose themselves as the present study unfolds. It will be shown **inter alia**, that lunar astronomy was as scientific as its solar counterpart.

OBJECT

The object is to present a non-technical view of the subject and a *prima facie* case : Textual criticism is out of place in an introductory monograph like the present which is designed not for the specialists but for a large class of readers especially the anthropologists, archaeologists, ethnologists, and the historians of astronomy, in addition to the Indian Vedic scholars : A more advanced text for the specialists is under preparation.

PERIOD

In the first part, the period covered is 6200 B. C. to 3100 B. C. and the study will be based on legends, rituals and myths which could be comprehended in a coherent scheme. Naturally, the conclusions will be based on an intuitive approach because the material is so meagre. After 3,100 B. C. concrete facts are more abundant and the Rig Veda supplies accurate trustworthy narrations though couched in not too difficult symbolism. By simply looking up at the sky many an apparent obscurity is removed, because the "**riks are written in the high heavens**", (R. V. 1.164.39.).

(1) O. Neugebauer, History of Ancient Astronomy, *Journal of Near Eastern Studies.* Vol, *IV*, 1945, p. 2.

In part II, which covers the period 20,000-6,000 B. C., the scene shifts northwards and mostly covers Europe, where the Paleolithic cave art flourished.

PEOPLE

The study covers all the Aryan people — Daevas, Hariyupians, Gandharvas and Ahuras as well as the border people of Anaus and Turvasas (the Turanians). The story begins, for the time being, with Ahura Mazda (Mahat Asura—viz Varuna) and Asha (Aditi — the priomordial Goddess of Ritam) in 6200 B. C.

In Part II, the people are the distant ancestors of the Aryans, perhaps the Cro-magnards.

OBSERVATIONS

Lunar astronomy was originally observational. Rudiments of knowledge about the movements and phases of the moon and their record existed even during the Aurignacean period — some 25000 years ago — as shown by Marschack. The present study is about the Vedic (and the Magian) astronomy which grew out of simple observations. Observations were made on the full moon and the new moon : on the seasons : on the points of sunrise on the horizon : on the northern and southern yearly swings of the points of sunrise with the seasons. Above all, the Vedic observers noted the particular bright star at (or near) which the full moon and the new moon occurred. All these were very simple, naked eye observations aided, if necessary, by distant markers, such as tall trees, hill-tops, edge of the riverbank, gaps and breaks on the skyline etc., **on the horizon.** Stonehenges were, in fact, astronomical observatories of the ancients, and a hymn of the Rigveda is found to throw some light thereon.

SOURCE

The primary source material is the data collected from actual observation : By observing the stepwise motion of the full moon among the bright stars (in the same way as was done by the prehistoric people), a theory of lunar astronomy was developed. It was supplanted by a parallel study of the Rigveda (in particular, hymn 1.164 by Dirghatama), the Gathas and the Tantric texts and practices. The Paleolithic cave paintings and stone figures provided further material.

EMPHASIS

This study is a part of a wider programme — viz, a scheme to build up an infrastructure of the chronology of the proto-historic **Aryana** — the land over which the Aryans roamed free. The emphasis of the work is therefore, on the chronology : fortunately, astronomy itself supplies good evidence of dates, because the astronomical observations on the cardinal days are themselves self-dating.

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I

Beginning of Astronomy

Ancient Heavenly Knowledge

Astronomy is a cold concept today—a cold science which means the knowledge of the movement of the inert (lifeless) masses moving in a lifeless sky. In the ancient prehistoric days, it was otherwise.

To the ancients, the heaven was the land of gods and mystery. The sky — the Dyaus of the Rigveda — was itself living. The stars were the abode of the gods. The shining stars were indeed themselves the luminous gods. Astronomy was the knowledge not of heavenly bodies, but of heavenly *beings* : It was the heavenly, celestial, cosmic or divine knowledge — knowledge of *devas* — the bright luminous gods. *Adhidaivata* interpretation meant 'cosmic' interpretation, and it was a warm and inspiring appreciation of *Ritam,* the grand cosmic law which no one — man or god — could disobey. *Ritam* was at the heart of the Veda and the Avesta.

It is particularly important to note that from the earliest times, this knowledge was sub-consciously correlated with time. Regular rhythmic movement of these bright celestial beings marked time : they were gods of time. *Maha-kala (Zeit-geist)* was also *Maha-deva* — the greatest God. The most ancient pre-Indo-European word for the day was *Dyu :* It is found in the Rigveda as such. *Devas* were also the *'dyus'*. They resided in the *dyu* (the highest heaven) and demarcated time i. e. the *dyus* (vide *infra*).

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They measured the year roughly by twelve full moons — the ancient year : A season *(Ritu)* measured two full moons of 59 days. Marshack has demonstrated that this knowledge existed even 25,000 years ago. For *convenience, the year of twelve full moons will be called the 'ancient year'* (and in Sanskrit — *parivatsara)*.

b. Pre-historic Lunar Astronomy and Time Keeping

The ancient wise man [magi, rishi, muni, by whatever name called] was also an astronomer, because he had, of necessity, to have a knowledge of the heavens and of the heavenly beings. The sky, the sun, the moon, the stars and their movements were known to him. In particular, he had the secret knowledge, the knowledge *par excellence,* of the *Nakshatras* — the bright stars (like Aldebaran, Pollux, Antrares, Alcyone, Betelguse, Orionis etc.) which were the house of the gods (*Devagriha vai nakskatrani* — Taittiriya Brahmana 1. 5. 2. 7)[1]

The ancient seer (seer of the heavens and the future course of events) knew, *inter alia*

1) The course and the recurrence of seasons ;
2) The proper timing of seasonal rituals and sacrifices;
3) The proper time for sowing and harvesting;
4) Proper times for hunting expeditions;
5) The proper indicia for the commencement of yearly activities, etc.

The onset of the seasons was marked by some typical characteristic phenomenon e.g.

a) General : Change of weather, blossoming of flower buds, appearance of herbs, rut in animals, fall of leaves, etc.

b) Specific : First fall of leaves on a particular tree, first blossom of flowers of a particular tree, first fall of rains, first appearance of migratory birds,

1) also "divi tishthati iti deva" Skandaswami; *dyu-sthana bhavti* iti" Yaska; Dr. Subbaraiyappa suggests the equation *deva* = luminary - a very apt translation, if it comprehends all that is bright and luminous.

The year was made to commence when one typical seasonal characteristic began: Usually, it was spring or the sweet mating season : In India, it was the autumn full moon which was the day of the great rejoicing: from the autumn full moon the cycle of seasons, the dance of *Mahakala (Zeit-geist)* began and Prajapati commenced his annual work.

Then followed astronomy i. e. the knowledge that seasons were connected with the moon and the stars. According to the Indian tradition the credit for this discovery goes to a great matriarch who was deified as the mother goddess *Aditi* — the mother of devas — i. e. the mother of the gods of time.

The moon was the man's first chronometer (time measurer); not the Sun. They measured months by the moon. The new month began when the new moon appeared. In sculptures the 'horn' marked this last (or first) phase. The horn representing the *cornucopia* of the Aurignacean (c. 19000 B. C.) was, in fact, the last phase of the vanishing moon, on a particular night (see part II, *infra*)

c. Moon—the maker of the Months

Yaska (1430 B. C.) referring to a very ancient tradition (ancient even in Yaska's time — 1400 B. C. !), says that originally the moon was the *masakrit* (= maker of the month) : That the moon measured the month as he moved among the nakshatras (= stars) — looking at them (R. V. 1.105.18 : Yaska's comments Nir 5.4.20. 1).

Trita Aptya, the maker of the hymn, belongs to the earliest stratum of Vedic hymns : his hymn runs as follows :— R. V. 1/105/8 *Aruno masakrid vrikah, patha yantam dadarsha hi*. Yaska explains mantra in Nir (5.4.20.1)

1) *Vrikah candrama bhavati* = Vrika means the moon.

2) *Vrika — vivrita jyotishka va vikrita jyotiska va vikranta jyotiska va*

   = waxing and waning (varying in illumination)

3) *Masakrid =masanam ca ardha-masanam ca karta*
= *Masakrid* means the maker of months (and half months)

4) *Patha yantam dadarsha hi =*
Patha yantam dedarsha nakshatranam
= By looking at the nakshatras (stars) on the way.

It follows that according to Yaska the meaning of the mantra is :—

Patha yantam dadarsha, aruna vrikah hi masakrid bhavati : The moon looks at the nakshatras while he moves through them : He waxes and wanes : He is the maker of the months.

This mantra is the secret chamber which contains the mystery of the pre-Vedic astronomy. Yaska's hint is the flood-light which illumines the dark chamber of prehistoric lunar astronomy.

Trita Aptya who composed the hymn belonged to the earliest stratum of the Vedic rishis, and was referred to in the Gathas as a divine being. Even Attri, who belongs to the earliest stratum of the Vedic age, refers (R .V. V. 41-9) to Trita Aptya as a semi-divine being. Trita Aptya, therefore, must belong to the pre-Vedic prehistoric age.

Trita was an astronomer, because the hymn R. V. 1.105 on *Visvedeva* is basically an astronomical hymn. His commentator *Kutsa Angirasa* of the late Rigvedic age was also an astronomer (c. 1,500 B. C., vide the astronomical hymn A. V. 10.8). The hymn R.V. 1.105, therefore, contains the earliest traditions coming down—perhaps from the prehistoric times and shows that the moon (and not the sun) was the first measurer of months.

II Beginning of the Year

a. Seasons and the Birth of Sciences

The original science (magic, chants, breath, totem, taboo, associative superstition, mantra, shamanism, magism — by whatever name called), must have been entirely utilitarian. All that could be helpful to man in his struggle against the environment and nature (or rather, all that was *felt and imagined* would be useful for preserving life) — was sought after : but nothing else.

One such primary need was to be acquainted with seasons and weather. For an orderly life — as much order as could be expected in those dark days — a knowledge of seasons was vital and indispensable. How was a season marked in the beginning ? *The original observations must have been crude and, therefore, simple.*

Summer was marked by heat, longest day (when the midday sun at its highest in the sky) which heralded the burning sun. The hottest day was soon followed by rain (in India). Men who watched the sun rise must have also noticed that *at the point of sunrise on the horizon* the sun moved northwards in summer and the other way in winter. The sun was at its northern-most point at sunrise marked by a distant hill, tree or pole—some fixed marker. According to Vedic people, this was determinable within ± 10 days i. e.

there was a marginal uncertainty of 21 days at the point of turning. Experts (nakshatradarshas or star gazers) could do it to within one day.

Rains :— The first shower of rains was perhaps another important day. In Bengal, there is still prevalent a primitive belief that mother earth is in menstruation in the rainy season.

Autumn :— The end of rains, when the whole nature looked fresh as after a bath, must have been also important. The first full moon after the rains must have been an occasion for joyous festivities.

Winter :— The winter was marked by cold. The height of winter was marked by

1) The coldest day

2) The sun at its southernmost point on the horizon at sunrise (marked by distant hills, trees and poles).

3) The shadow was longest at midday

4) The shortest day

Spring :— Spring was the sweet season (*Madhu ritu*). It was the season for mating and lovemaking. Some anthropologists believe that primitive women had a 'season'; that they did not allow men to approach them except at a certain season. These were the five seasons of which the autumn was the longest and in many ways the most important.

Flowers and Fruits :— A sharper and more regular event which marked the season was the observation made on a particular tree or plant e. g.

1) First flowering of a particular tree or plant
2) First appearance of certain plants (*Oshadhis*)
3) First fall of leaves
4) First appearance of *'bauls'* (flowers on mango trees,) etc.
5) First mating (of rut). This was extremely important for a hunting community.

6) The appearance of the migratory birds must also have been an important indicator of the season.

and so on.

How accurate were these observations? They were quite accurate, more accurate than most people think. Usually, they recur within 20 days every year i. e. within $\pm$ 10 days of a particular day. This is why the pre-vedic people used a 21 day period to determine it.

[Anticipating a little, we note that $\pm$ 10 days in the onset of season — means a difference of $\pm$ 700 years in chronology. This is good enough when we go to 5000 B. C. and further. Please see infra.]

b. Ritu : Females and Seasons

Primitive men and women must have noticed the regularity in the succession of the seasons : that summer, rains, autumn, winter, spring, *and again summer* followed in regular inviolable succession. A person living for 30 years would notice it, but who noticed it first — men or women ?

It was a female who noticed it first; for, she has an internal clock (the menstrual cycle) which ticks once a month. this fact, it will be presently shown, is of supreme importance in the chronology of the birth of sciences.

Females knew (if vaguely at first) that their menstrual cycle coincided with the monthly moon. If there was a full moon in the current period, the next full moon would coincide with the next period. Similarly, if there was a new moon, the period would recur at the next new moon. The connection between the menstrual period and the moon would have been noticed in the late palaeolithic period (say, 30,000 years ago) though it was not perhaps then named adequately for want of words : It was known in the mesolithic period if not earlier — for, it *was vital for a female to know about the regular periods as well as its stoppage.*

They must have also noticed that their flow stopped when pregnant and that after ten moons (stoppages), a child was born. [See R. V. 10.184 where new moon is invoked to preserve the pregnancy and for the birth of a child at the tenth month]

A female who noticed the unision of the rhythm of the full moon (or of the new moon) with her own cycle would very soon get a good idea of a long period of about a year. She would also notice and observe that the rhythm of the seasons coincided with her own rhythms. What is important — she noticed that *summer returned after about twelve periods.*

What is the reason for this hypothesis ? *In Sanskrit, the same word 'ritu' signifies both.* Ritu means a season as well as the menstrual period since prehistoric days. This identity conclusively establishes, that the females in the prehistoric days knew of the correspondence viz. the correspondence between the full moon, the seasons and their own cycles.

Philology :

Indo European words — *dyu, moon, ritam*

In this study, it is necessary to know the philology of three Indo European words — ritam, dyu and moon — which go to the earliest pre-history of the Indo-European Aryans and which belongs to their original home, wherever it was.

DYU

The word *Dyu* is one of the earliest Indo-European words known. In the Rig Veda, it means either a 'day' or 'heaven' : Yaska who lived in c. 1, 400 B. C. gave both these two meanings in his lexicon — the Nirukta. The root has given rise to many European and Sanskrit words :—

European : Dieu, Deity, Diuarnal, Divine and Day;

Vedic : Dyu (Heaven), Dyu (Day), Divi (heaven) Deva (god) Dyaus (=Zeus), Divasa (day), Dyava (heaven), Dyuti (bright light)

Hindi : Din, Deo, Deota, etc.

THE MOON

The primitive man of the pleistocene age used the Moon (and not the Sun) as the time - measurer. Marshack has shown that the Aurignacean knew that the moon completes two full moons in 59 days (in sets of 30+29, or more probably, 15, 15, 14, 15). Yaska says "Moon is the maker of months".

The ancient pre-vedic Indo-Europeans also used a season of two months, and called it a RTU. The word 'moon' and 'ritu' are Indo - European words of key significance as will be presently shown.

The English word moon is related to measurement of time *via* female menstruation, both being derived from the root 'me' — to measure. The O. E. D. says :

Moon : Fr. root 'me' — to measure

Month : In old Teutonic related to MAENON—moon.

Meno : Month in Greek :— relating to menses.

Mens : Relating to menses.

Mensal : Monthly

Mense : Neat, proper, decorum (vide RTm *infra*)

Menstrual : Happening once a month — now used in astr.; relating to femal menstruation.

As stated before, a female must have noticed, even in the early pleistocene age, the correspondence between the full moon (and/or new moon) and her own monthly period of menstruation. For instance, in the Slavonic languages, the same phoneim denotes the full moon, the month as well as menstruation.

Polish :

MIESIACZKA	—	menstruation
Miesiac	—	moon, month

In Sanskrit, *Purnima* (= full moon) is derived from *Purna—masa* which means full month. A month is full when the moon is full. The vedic root *ma* signifies measurement : It is suggested, therefore, that here 'moon' in its root connotation is the measurer of time.

d PHILOLOGY OF 'RITU'

In Sanskrit the word ṚTU is spelt with a cerebralized vowel R. As all cerebralized words must have been the first to grow (being like grunts), it must have been a very old word indeed. Before proceeding further, we give some words having their root in RIT (Sanskrit Ṛ T). We use the word RIT here instead of ṚT, for facility in pronunciation — particularly for the Europeans.

Root=RIT (=ṚT)

Ritu	=	Season
Ritu	=	Menstrual cycle of a female
Ritam (Rigveda)	=	Law, Truth
Ritam	=	Grand cosmic law

Derived words

Right (English)	=	Correct
Recht (GERMAN)	=	Correct
Rite (English)	=	Festival (connected with a season?)
Ritual (English)	=	Ritu—al (connected with a season originally)
Ritam Brihat	=	Grand cosmic law.

Ritasya sadanam (ritasya yoni)	=	House of Rita (Points of the equniox in heavens)
Rhythm		Regularity, order as in ritus (Note the identity in pronunciation)

RITU-NOMY

We shall christen the primitive science of seasons as *Ritu—nomy* (Ritu—Season : nomy=science) instead of meteorology. This will not only do honour to the first lady who discovered science, but will make Europeans more conscious of a word denoting law viz., RITAM

It is clear that the roots 1) dyu, 2) men and 3) *ṛt go back, at least, to Indo-European period, if not earlier.* Presumably, they go back to the very dawn of the awakening of the human mind.

d. SEASONS AND FESTIVALS : SACRIFICES

In those prehistoric days, the onset of seasons was marked by festivals and rituals : By sacrifices.

Even for the hunting food-gleaning tribes, a rudimentary knowledge of the seasons [and, in particular, of their onsets] was of utmost importance. They would like to know where and, in particular, *when* to find (a) fruits (b) corns and (c) beasts of prey. Perhaps mating was also restricted to certain seasons only. A knowledge of the seasons would be a life-preserving necessity for the hunting and food-gleaning society.

When the tribes reached the food producing and agricultural stage of culture, a knowledge of seasons (good enough to forecast the onset) was a *must.* An agricultural society must know when and where to begin the long complex process of agriculture.

As soon as a fore-knowledge of seasons dawned on some men (and women) magic started. Elders who lived up to 40 autumns or more would know that the seasons followed in a regular order

like autumn, winter, spring, summer, rains and, then, autumn would come back to begin the fresh cycle. As soon as the knowledge became specific, the onset of the autumn was marked by *rites*, feasts and dances.

These rites and feasts were soon celebrated on the full moon nights (rarely, also on new moon days — particularly when the magic was black). The fact that originally the rites and the rituals were connected with the seasons, will be apparent from the fact they both spring from the root rt (u) which means a season.

Ritu (—al) thus, originally meant (in those prehistoric days) season-feast or season-food. The Christian mass has also the the same origin; for, in Sanskrit, '*mas*' meant meat as well as months.

A ritual was marked not only by a community feast but also by community dances. Spring was a most important occasion for community festivals and dances; for, it was the signal for the sweet season of mating. Spring is still called *Madhu ritu* or the sweet season. In the *Holi* of India (observed on a full moon only) we have still the relic of those primitive orgiastic festivals. [cf. Dionesic festivals of Greece].

In classical Sanskrit literature, we have a beautiful instance of of the remnant of such a spring festival and female magic viz. the *dohada*. On the dohada day, a beautiful girl (maiden) kicks an *ashoka* tree and the *ashoka* tree then flowers. This flowering of the *ashoka* tree — the appearance of the first flower—marked the onset of spring. Another such (female) magic was the kissing of the '*bakula*' — when it would blossom.

The appearance of the first flower (of a particular tree) the appearance of the first fruit, the appearance of the corn, the ripening of the fruits, all marked the onset (or bloom) of a season: These were naturally the days of thanksgiving for the gods.

The seasons, its cycles, its onset, its full vigour, were all of supreme importance in the primitive life. They were marked not

only by community festivals, dances, feasts but also by offerings for thanksgiving. These offerings become ritual sacrifices, which soon grew into magical rituals which would enforce fruition and vegetation. *In those dark days, men had only a dim knowledge of cause and effect, and often confused and mistook one for the other: This was the origin of magic:* and it should be noted that magic was the precursor of all sciences.

In pre-Vedic and Vedic communities, fire was also an important element in the rituals. By the mesolithic period, fire was controlled i. e. it was produced and preserved. However, the production of fire (lighting of fire) was by no means an easy job. It was a difficult job for the experts. It was produced on these special occasions (seasonal rituals) and then preserved carefully. Thus, in pre-Vedic communities, lighting of the sacred fire—from which the members drew their own fire — was linked with the great communal festive occasions marking the *ritu*.

III

Full moon, Seasons and Stars

ADITI.

In the pre-vedic communities, another important element in these seasonal rituals, was the observation connected with certain bright stars. The clue is found in the vedic legend that *Aditi was the mother of gods and the important fact that all the vedic gods were linked with certain stars.* Thus, we have, for the important stars :

Deity	Nakshatra (Indian)	Star (European)	Longitude (1970 A D.)
Indra	Jyestha Rohini	Antares	249°
Prajapati	Rohini	Aldebaran	69°
Rudra	Ardra	Betelguse	88°
Aditi	Punarvasu	Pollux	113°
Varuna	Shatabhisaj	Aquari	341°
Pitri	Magha	Regulus	149°
Daksha	Abhijit	Vega	285°
Sotee	Sotee	Sothes (Sirius or Canis Major)	104°

*Vedic astronomers knew that astronomically, the god meant the star and vice versa :** The same is true for many prehistoric nations; for, every god has a luminary and *vice-versa* (see e. g. ISHTAR)

Very early, perhaps in the mesolithic period, about 10,000 years ago for certain, - perhaps 20,000 years ago - who knows ? someone noticed that the onset of a particular season occured when the moon was full near a particular bright

* Colebrooke, Misc. Essays, Vol I, p 98; also Burgess, J. A. O. S., vol VIII. p, 317)

star: That there was autumn when the moon was full near the "autumn-star". Vedic lore has it that Aditi first systemized this observation : She is the *Devamata* — mother of the gods. (1)

Aditi is now represented in the heavens by the bright star Punarvasu i. e. Pollux (long. 113°) of which she was the presiding deity. When the moon was full at Aditi it was autumn. The precession of seasons is now 113° because the autumn (Autumnal equinox) takes place today when the sun at 180° i. e. when the moon is full at 0°. This means a lapse of 8,136 years at 72 years per degree or say, 6,166 B. C. This was, perhaps the earliest onset of organized neolithic age.

It should be noticed that the observation is particularly simple viz. the bright star (in this case Pollux) at which the full moon occurs. This occurred in autumn i. e. after the rains, when the sky was particularly suitable for observation, being at its clearest and brightest.

Once this crucial observation was made — which identified a bright star with the seasons — *a most important step was taken in science.*

The observation of Aditi — we see in the retrospect now — united the seasons (a phenomenon on the earth), with female menstruation (a phenomenon inside human body), and the purnima at a bright star (i. e. a phenomenon in high heavens). The same law governs the human body, the earth and the high heavens. IT WAS CALLED RITAM — RITAM BRIHAT — *which means literally the grand* cosmic law.(2)

Aditi — the mother of the gods — created science by her simple observation some 8000 years ago, when she made her star Punarvasu (Pollux) the autumn star.

Ancient Brahmavadins (Vedic scholars) say that there are three interpretations to every mantra—*adhyatmik* (inside the body),

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(1) Aditi = *adina devamata*, Yaska, Nirukta, 4. 4. 22. 1.

(2) In the Avesta, Aditi becomes Asha — the soul of Ritam and Mazda (=Varuna) is her consort : Note that Ahura Mazda = *Mahat Asura*

adhi-bhautik (or on the earth) and *adhi-daivik* (or cosmic). The reason for this assertion is linked with Ritam, the grand law which works in all the three planes.

There is yet another plane—for, Vak (=Logos) works in four planes. That is secret and known only to those who are seers i. e. who have divine inspiration of the supraconscious.(1)

b. DAKSHA : VEGA AS AUTUMN STAR

The next stage in evolution of Aryan science took place when Daksha—Sotee system was evolved. After about 700 years, the seasons advanced due to precession, and equinox took place when the moon was full at Vega (Daksha=Long 284°). Autumnal equinox (autumn) took place at Sotte Purnima (Canis major — long 104°) while spring equinox at Daksha Purnima. Daksha (Vega) was naturally called the son of Aditi (Pollux) and Sotee was Daksha's daughter. The union of antepodic stars (longitude 104° and 284°) as father and daughter shows incidentally, that the nakshatra-darshas (star gazers of those days) had a dim notion of the celestial sphere : They knew that the *sky was a sphere.* Daksha started a regular scheme of sacrifices (Yajnas) : This took place about 7500 years ago i.e. in about 5400 B. C.

c. RUDRA : BETELGUSE AS AUTUMN STAR

Finally, after yet another thousand years, the seasons advanced by about 16°, and the correlation with Vega was found wanting. A new Autumn star was necessary. The new autumn star was Rudra (or his star Betelguse, Long. 88°).

The fact that Shiva (Rudra) was made the autumn star is given in a puranic legend (Vayu Purana : 32,6 ff).

"After a thousand *parivatsaras* (ancient years), the gods lost track of time. They were perplexed and went to Mahakala (Shiva). Shiva fixed the epoch for them."

(1) Vide Sasanka Bhusan, Katyayani, Delhi 1971 :

Obviously, it is an astronomical legend, and it means that Shiva (i. e. his star Betelguse) was made the autumn star, and the year began when the moon was full at Betelguse. The selection of Betelguse (Rudra) as autumn star took place in c. 4,370 B. C. This selection was not 'peaceful' and apparently there was a struggle. This struggle gave birth to the legend of *Daksha yajna bhanga* i. e. breaking of the Daksha cycle of rituals.

Shorn of allegories, the legend of *Daksha-yajna-bhanga* means this :—

1) Daksha cycle (i.e. the cycle of Vega was broken or abandoned.

2) Daksha was killed i. e. cast out of Nakshatra system : (Actually the older system was made up of 28 stars : By casting off Vega, the new system was made up of only 27 stars.) Daksha was revived only as a goat-headed deity.

3) Sotee committed suicide : She was also thrown out of the system. Actually, before she was cast off completely, a compromise was made by marrying her with Shiva—the incoming autumn star, but this union also did not work.

4) Rudra or Shiva (Betelguse) was made the new Autumn star. The selection of Rudra is confirmed by another fact. To this day, Shiva is worshipped on *Phalguna Krishna Caturdasi.* The winter solstice took place on *Phalguna Krishna Caturdashi in* c. 4370 B. C.

d. MARGIN OF ERROR

It is necessary to know about the margin of error, when a date of remote pre-history is fixed by the precession of seasons.

In the prevedic days, the seasonal festival was held for 21 days and, the middle day called the Abhijit day (the day of Daksha) was the most important.

This shows that they knew the margin of error was $\pm$ 10 days.

Even an uninitiated boy can easily recognize by the end of December (i. e. after ten days of the winter solstice) that the weather has warmed up and that the days have lengthened.

In chronology, the shift of a day means 72 years because, the sun moves through 1° in a day. An uncertainty of ten days means an uncertainty of 720 years.
Hence, we get :

Aditi period	=	6100 B. C. ± 700 years
Daksha period	=	5400 B.C. ± 700 years
Shiva period	=	4300 B. C. ± 700 years

We shall compare it with the margin of error in radio carbon method.

Suess has shown that beyond 1000 B. C., the radio carbon dates are too low. The correct date is given by the formula

$T = 1.4 \times R - 1100$
Where T is the true date (before 1950)
R is the radio-carbon date (before 1950)
Thus, suppose the radio-carbon date is 5,150 B. C.

$$
\begin{aligned}
T &= 1.4 \times (5150+1950) - (1100+1950) \\
&= 1.4 \times 7100-3050 \\
&= 9940-3050 \\
&= 6890 \text{ B. C.}
\end{aligned}
$$

Hence, the range of dates is (5150—6890) B. C. and it could be said that the radio-carbon date is 6020 (± 870) B. C.

Thus, we have the comparative margins as follows :-

Period	Precession of seasons	Radio carbon
	B. C.	B. C.
Aditi period	6,100 (± 700)	6,020 (±870)
Daksha period	5,400 (± 720)	5,420 (± 770)
Shiva period	4,400 (± 700)	4,320 (± 610)

In the range (4,000—6,000) B. C., the two methods are comparable, while beyond 6,000 B. C., the accuracy of radio carbon method is comparatively inferior to precession of season method. In fact, the recent chronological analysis of the annual tree ring formation of the bristlecone pines show that a correction of 10% must be applied beyond 1000 B. C., to establish historical concordance (1)

In about 4300 B. C., the Indians marked the seasons by equinoxes and solstices because their astronomy had sufficiently advanced by that date [vide Playfair : CALIYOUGAM]. Thereafter, the accuracy increased to ± 5 days (=350 years) and by Manu's time in 3,100 B.C , the accuracy was ± 3 days [= 200 years]. In Vegambhrini's time [c. 1,700 B. C.], it was correct to a tithi [i. e. correct to ± 70 years].

To sum up :

1) Aditi, the great matriarch, first discovered the connection between the stars and the seasons. She started the year with full moon at Aditi, and Aditi (Pollux) was made the autumn star. Pollux was the autumn star in *c.* 6100 B. C.

2) Daksha (Vega) was the next autumn star. The choice took place *c.* 5400 B. C.

3) Betelguse (Shiva) was the next autumn star. The replacement took place in *c.* (4400—4200) B. C.
   [This replacement is confirmed
   a) by the legend that Shiva fixed the epoch for the devas when they were perplexed.
   b) by the legend of *Dakshayajna-bhanga*.
   c) by the observance of *Phalguna Krishna Caturdashi* as Shiva's night]

4) Rohini replaced Shiva in 3070 B. C. This was done under the ordinances of Manu, the paramount king, with the help of Nabhanedishtha, his astronomer son. With Manu, we enter the protohistoric age of Vedic India - which will be separately dealt with, subsequently.

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(1) S. B. Roy, *Puratattva*, Harappan Chronology, vol. 7, p. 65.

5) a) Ritunomy — the ancient knowledge of seasons — was the first science of humanity.

b) The credit goes to Aditi — a lady astronomer — the great matriarch who has been rightly deified as the mother of the gods.

6) The successive 'shifts' of the autumn star is shown in the following table :—

Epoch *circa*	Autumn star	Seer	king (?)	Deity
6,200 B. C.	Pollux	Aditi	Varuna	Aditi
5,400 B. C.	Vaga/Sirius	Soti	Daksha	Daksha-Sotee
4,350 B. C.	Betelguse	Virabhadra	Rudra	Rudra
3 070 B. C.	Aldebaran	Nabha-nedishtha	Manu	Prajapati

IV

Length of the Year : Intercalation and the Devaganas

a. THE PROBLEM : The Devaganas

The key problem for the ancient astronomer who measured time (i. e. the month) by the moon and a year by twelve full moons, was : how to synchronize the seasons with the moon i.e. to synchronize the seasonal year with the lunar synodic year of twelve moons. To understand the pre-vedic approach, one has to understand first the function of the *devaganas*; or groups of gods — the collective gods—working in concert to measure time. He who knew this was the *RITWIK (Ritu-vid)* or the knower of the seasons.

The nature of the collective gods—Visvedevas, Rudras, Adityas and Vasus and the 'seven sisters' are, therefore, now discussed. They are found to be connected with astronomical concepts, having chronological (time marking) functions : They are the gods of time, viz. the gods of a species whom Varahamihira called the Lords of the year (Panca-siddhantika p. 1.24)

While giving the meaning of the words Vasus, Rudras, Adityas and Visvedevas in his Wortherbuch, Grassman says that they belonged to certain *'gotter—klassen'* i. e. classes of gods. For instance analysing the concept of he Vasus, he says :

> "Vasu—a class of gods who are mentioned
>
> a. along with the rudras and adityas,

or,

b. along with one of these two classes of gods or,

c. along with the adityas and the visvedevas and ratyas"

However, Grassmann did not proceed to give the functions of any of these classes, and, in this essay, we shall try, if possible, to ascertain these functions.

b. VAGAMBHRINI AND THE DEVI SUKTA (RV. 10.125 1)

Vagambhrini, in her celebrated *Devisukta,* gives the names of these four Devaganas, along with certain individual gods. Paul Thieme has discussed these individual gods *and their functions* in his study of the Boghas Kuei inscriptions.(1) However, he has also not dealt with these 'god-groups', because they do not appear in the treaty.

Vagambhrini says, in the opening of her hymn *R. V. 125.1*

'I *move* with the Rudra, the Vasus, the Adityas and the Visvedevas'.

Grassmann's enumeration of the four *ganas* is, therefore, correct because vagambhrini mentions these very groups. It is to be particularly noticed that Vak says "*carami*", = '*I move*', while talking of these *devaganas* or god groups; but, she says '*vibharmi'— 'I sustain',* in respect of the others i. e., the individual gods. This shows that the concept of these *devaganas* is unmistakably connectd with time because:

"*CARATI KALAH* : Motion is the essence of time : Newton, the father of classical physics also says, '*Time is that which* flows uniformly past".

Incidentally, this discloses why the *Tantrikas*, the worshippers of *Mahakali* — the supreme goddess of time — take this hymn as their *yoni-mantra* — the principal article of faith. The mother goddess declares herself to be the moving spirit viz. the spirit that

(1) P. Thieme, The 'Aryan' gods of the Mitanni tribes, JAOS. 60, pp. 301-17

moves the gods the time. She is, therefore, herself THE godddess of time — the *time-geist* — the *mahakali.*

Vagambhrini, be it carefully noted, knew astronomy. She observed and established the winter solstice at *Magha shukla Pancami* (1)

c. INTERCALATION

1. THE FIRST STAGE OF ASTRONOMY — Thirty three devas

In the most ancient portions of the Rigveda (Third mandala 3.6.9) by Viswamitra (D. N. 32 b. 2609 B. C.), the number of 'all gods' — the Visva devas — is said to be thirty three. Sometimes the number is not specified, and the term all-gods or Visvadeva is used. However, if a specific number is mentioned it is thirty—three (see for example, the Vaiswdeva Nivid). In the famous philosophical conference of king Janaka, Yajnavalkya said that the original number of gods was 33, and the others were but their glories (B. U. 3.9.1). What is the significance, if any, of this number thirty three ?

It should be remembered that even in Visvamitra's time (c. 2,600 B. C.) the concept of Visvedevas was so old, that the individual names of the 33 gods were forgotten. Only the memory remained that the number of all gods was 33. We shall, therefore, have to go to the pre-history, in search of the origin of this mystic number 33. Let us see whether our hypothesis that primitive god concept was linked with the concept of time (seasons, etc.), offer any clue.

In the most ancient days, the days beyond the pre-history, they had no concept of the solar year (i. e. tropical or seasonal year) as we now understand it. They used a simple year of twelve full moons for a rough and ready recurrence of the seasons i. e., a synodic year or, what we have christened to be a *parivatsara.* Naturally, there was no precise concordance between the seasons

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(1) S. B. Roy, Chronological Intrutructure of Protohitone India JBORS-1972, Vol H LV III, P. 60

and this synodic year, because this synodic year was short of the true seasonal year by 11 lunar days. (True year 371 tithis; synodic year=360 tithis, vide *infra*). Seasons fell back, and continued to fall back throughout the year. We have this system even today in the Islamic religious calendar: The religious function ID may be observed in the winter today; after some time, it will be in autumn, while after some time more it will be in summer. We are indeed indebted to the Islamic calendar makers for carrying this most ancient tradition of human awakening.

A seer — perhaps Indo-European, perhaps Magdellanean, perhaps Aurignacean, who knows? — found that after 33 synodic years (= an ancient year of twelve moons — the only year known to them), *the seasons recurred.* Naturally, they had 33 gods to mark out these 33 years. Their names were long forgotten, but the tradition of 33 cosmic gods — the Visvedevas — have been faithfully carried over in the most ancient portions of the Rigveda as mentioned above. In the Panca-siddhantika of Varaha, one gets a faint echo thereof in the 30 Lords of the year. (1-24.)

We believe that these gods became collectively Visvedevas when their individuality was lost, because as will be shown presently, a different system of astronomy and calendar making was then adopted. Incidentally, all the Visvedeva hymns of the Rigveda have an astronomical (cosmic) colour if they are not wholly astronomical.

Although not a useful marker of seasons, and, therefore, useless as a guide to the sowing seasons etc., the system was remarkably accurate as a measurer of the length of the true seasonal year, because in 33 synodic years, when the seasons recurred, there was a passage of 32 true seasonal years. Hence,

$$\begin{aligned} 32 \text{ seasonal years} &= 33 \text{ parivatsaras (synodic years)} \\ &= 33 \times 360 \text{ tithis} \\ \therefore \text{One year} &= \frac{33 \times 360 \text{ tithis}}{32} \\ &= 371\tfrac{1}{4} \text{ tithis.} \end{aligned}$$

The true seasonal year is 371, 1/19 tithis; The primitive Vaisvadeva year was, therefore, remarkably accurate.

One may perhaps link it with the earliest Magian concepts beginning with Ahura Mazda: Later on, the Magis believed in thirty lords of the year beginning with Ahura Mazda. How the number 33 of the Rigveda changed to 30 of the Avesta will be understood only when Viswamitra's theory is explained.

However, the scheme was not practical at all, because you cannot allow the seasons to roll round the year. In fact, for the purpose of agriculture, it is worse than useless. You cannot ascertain the *'ritu'*, and, therefore, cannot perform any agricultural ritual : an expert — *'ritvik'* is essential to find the seasons correctly.

The problem was to synchronise the seasons with the synodic year, and was solved by the method called the method of 'beats' by which synchronisation is achieved by physicists, watchmakers and musicians. In astronomy, this method is called INTER-CALATION, and to this we now turn.

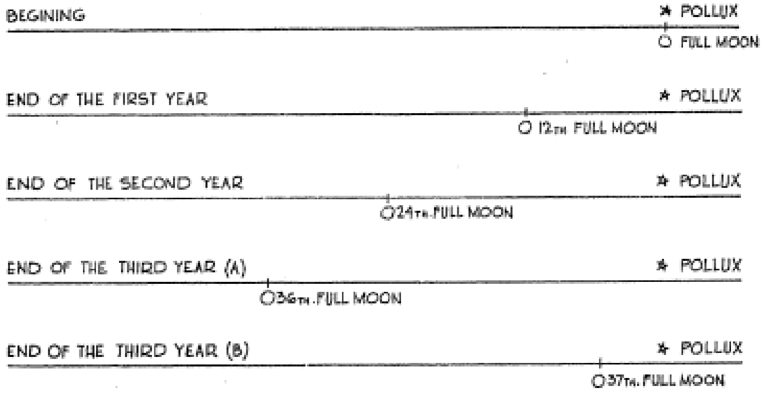
2. SECOND STAGE (PRIMARY INTERCALATION—THREE YEAR CYCLE)

The solution was found when man looked up at the sky. As we said before, the credit goes to the great matriarch Aditi, who made the grand discovery that the seasons are linked with the stars. She established in c. 6,100 B. C., that autumn occurred when the moon was full at Punarvasu (= Pollux).

(Actually, there are reasons to believe that the discovery was made very much earlier, by new moon, but we leave that research for the part II of this work. Here, we shall only give a continuous story from 6,100 B. C. onwards.).

Aditi, the great matriarch of the Indo-European days, then ordained that the autumn festival should be held when, *and only when,* the moon was full at her star Pollux. This simple directive, necessarily led to intercalation as will be shown presently.

Continuous look at the skies for a few years would show that the autumn full moon (i. e. the twelfth full moon) fell back by about eleven degrees (or eleven dyus or eleven days or eleven tithis) every year:



Thus, at the end of the third year, an extra full moon will be needed to bring the full moon back to Pollux : The third year would be made up of THIRTEEN full moons instead of the usual twelve full moons.

The yuga of three years, would, therefore, be made up of 37 months instead of the expected 36 months and a year would be made up of 370 *tithis* instead of the usual 360 *tithis* of the synodic year. (Three years = 37 full moons = 30 × 37 *tithis* = 3 × 370 *tithis*. Hence, one year = 370 *tithis*).

The extra month needed in the third year, is called the intercalary month or the extra month; (*Adhika masa, mala masa malimluca* or *anhaspati*).

Varuna knew this extra month (R. V. 1/25 : Varuna also made a path for the sun i. e., he discovered the ecliptic, and Aditi was Varuna's consort. Aditi and Varuna worked together : in the Gathas, they became Asha * and Ahura Mazda respectively. As shown before, this happened in C. 6100 B.C. In Karnataka of South India, a three year system is still in operation.

(It is perhaps possible that the three years of the yuga, had three goddesses, Ila, Saraswati and Mahi (or Bharati) as their deities. The *Aprisuktas,* belonging to the most ancient portions of the Rigveda, mention Devi-dwara — the gates of the heavens, which have been identified as equinoxes (Tilak) — along with these three goddesses. This identification is suggested because the first year of the three-year cycle is called *Idvatsara* — a corrupt form of *Il'a-yatsara.* It calls for further research).

3. THIRD STAGE(SECONDARY INTERCALATIONS)

Three year system, however, is not perfect. It falls short of the true year by about a tithi (lunar day), the year being actually made up of 371 *tithis* instead of 370 *tithis* as taken above. Observationally, the full moon is short of Pollux by about three degrees at the end of the yuga of three years i. e. by about one degree every year. This accumulates over the years, and further correction is necessary.

One simple method would be to wait for about 30 years and then, to add an extra month. This would mean eleven intercalations in thirty years instead of the usual ten, and would give a year of 371 *tithis.* This is a good *theoretical* method, and was proposed by Viswamitra. However, it is only theoretical, because practical observations need earlier corrections (i. e., earlier intercalations) as would be shown presently.

The practical observers, the *ritviks,* and, in particular, the specialist *nakshatra-darshas,* would achieve the same object by

*Other instances where male god is changed to a female god on the personification of an abstract quality is known. The moon is female as well as male; even the sun has been taken a female.

accelarating the intercalations. Thus, an intercalation at the end of the *eighth* year, instead of the usual ninth year, would be practical. This system would mean a *yuga* of eight years — and a year of 371, ½ tithis, instead of the correct year of 371,1/19 tithis. The system with three intercalation in Eight years is thus, slightly *overcorrected*. This was the system of Vasus, there being eight Vasus — the lords of eight years of the yuga. This period of eight years may be called the the Vasu yuga or Vasu cycle.

Alternately, there could be an intercalation at the end of the eleventh year instead of the twelfth. The yuga would be made up of eleven years. This was the system of Rudras, eleven Rudras being the lords of the eleven years of yuga. This means a yuga of eleven years — the Raudra cycle — with four intercalations, and results in an year of 370, 10/11 tithis, instead of the true year of 371, 1/19 tithis. It is thus, slightly *under corrected*.

The Rudra cycle is thus under-corrected, while the Vasu cycle is over—corrected. *By combining them, one gets a correct year.*

If a Rudra yuga of eleven years (with 4 extra months), is followed by a Vasu yuga of eight years (with 3 extra months), we get a yuga of nineteen (11+8) years, containing seven (4+3) extra months. This system was apparently adopted at the time of king Bharata, rishi Viswamitra and Dirghatamas, the famous astronomer rishi, who composed the astronomical hymn RV I—164 (c. 2350 B. C.). Dirghatama calls the seven intercalary months to be the seven sisters (R. V. 1.164. 3), or seven secret names (R. V. 1.164.3) They used seven threads as nemonic to remember them (R. V. 1.164.5).As Viswamitra and Dirghatamas lived when Krittika (Alcyone) was the autumn star, the epoch is found to be 2,350 B. C. In the Mahabharata, Viswamitra, the co-worker of Dirghatamas is credit-ed with the legend of the seven mothers, Krittika, Agni and Skanda. In Hariyupean seals of this period (c. 2350 B. C.), one sees seven sisters.

Thus, with the seven mothers (i. e. seven intercalatory months), we get a perfect cycle of nineteen years, which can be looked upon as a fusion of the system of Vasus and the Rudras, coming

in everlasting succession — the system being correct to almost 300 years.

Some readers would like to have a precise mathematical picture of the systems developed above. A mathematical statement of the above discussion is accordingly now given in the following chapter. This will also help one to understand later the peculiar development of Siddhanta astronomy (Dasagitika and Surya siddhanta) which is acknowledged to be characteristically Indian.

V

Mathematical analysis of the theory

Mathematical theory of astronomical approximations

The method of observational approximations (i. e. of the beats or intercalations) being explained, the subject of mathematical approximations may now be taken up. The mathematical astronomers can understand the theory of observations from the following self-contained note.

The known parameters of the revolutions of the sun and the moon are :—

The mean tropical year = 365. 2425084 days

The mean synodic month = 29. 5305988 days

The tropical revolution of the node = 18.61127 years

The tropical revolution of the moon's perigee = 8.84527 tropical years

The mean motion of the moon's node = 69636,6596 second per year.

We, therefore, get

Tropical year = 12+ 1/2+ 1/1+ 1/2+ 1/1+ 1/1+ 1/18+

The convergents are 12/1, 25/2, 37/3, 99/8, 136/11, 235/19

(The figures are taken from P. C. Sen Gupta, A. I. C., p, III)

These convergents tally with observational figures already obtained :—

37/3 = Adti—Varuna.
99/8 = Vasu; Cadmus.
136/11 = Raudra;

235/19 = Dirghatamas; Meton.

(b) The convergents to the semi-revolution of the Moon's node in tropical years can be similarly worked out to 9/1, 28/3, 93/10, 121/13, 235/36

or

9, 9 1/3, 9 2/19, 9 4/13, 9 11/36 tropical years

It should be particularly noticed that according to Sen Gupta, the first convergent to the semi-revolution of the moon's node is 9 tropical years which comes to 3339 *dyus* because one year is equal to 371 dyus.

One may now summarise the results arrived at, for the convenience of the theoretical astronomers.

INTERCALATION (Some definitions)

Units

One synodic month—one new/full moon to the next.
= 30 dyus (lunar days or tithis)
= 29.53088 civil (Savana) days.

∴ One dyu (= tithi) — .9843 53,9333 civil day

Definitions :—

One civil (Savana) day = One sun-rise to the next.

One sidereal (Arksho) day = One star-rise to the next.

One lunar day = One synodic *dyu* (vedic)
= One *tithi* (Post-vedic)
= Thirtieth part of a synodic month

One Solar month = Time taken by the sun to go from one rashi to the next (variable)

One savana month = 30 civil days

The tropical year = Time taken by the sun to go :—
From one vernal equinox to the next
or From one autumnal equinox to the next
or From one solstice (winter/summer) to one next

One sidereal year = Time taken by the sun to move from one nakshatra back again to the same.

Ancient prehistoric (pre-vedic) people used the star bound or the sidereal year : Various approximities were as follows :—

1) Original primitive calendar

One Vaisvadeva year = One parivatsara = 12 Synodic months
= 360 dyus (short by eleven *dyus.)*

[Islamic religious calendar still follows it. The seasons rotate round the year in about 33 synodic years. These *thirty-three* years were marked by 33 gods (Viswedevas in the pre-Rigveda astronomy.]

2) THREE YEAR YUGA [Vamana-Vali]

Basic period	= 3 years
Extra months	= one
New/Full moons	= 37
Yuga period	= 37 synodic months 1,110 dyus
Year	= 370 dyus (tithis)

(This is equivalent to 364.2 days : Discoverer Aditi : Short by one day).

3) FIVE YEAR YUGA [Pitamaha Bhisma]

Basic period	= 5 years
Extra months	= Two
New/full moons	= 62
Yuga length	= 1860 dyus
Year length	= 372 dyus

(Discoverer Pitamaha Bhisma; year = 366.20 days. Too long and crude : however, it was the basis of the first predictive popular astronomy in India).

4) EIGHT YEAR YUGA [Vasus]

Basic period	= 8 years
Extra months	= 3
New/full moons	= 99

Yuga period	= 99 synodic months
	= 2970 dyus
Length of year	= 371¼ dyus

(Discoverer : Vasus : the eight years of the yuga were marked by eight Vasus.)

5) **Eleven Year Yuga** [Rudras]

Basic period	= 11 years
Extra month	= 4
New/full moons	= 136
Yuga period	= 136 synodic months
Length of the year	= 370, 10/11 dyus.

(Discoverer Rudra, 4,320 B. C. The eleven years of the yuga were given to the eleven Rudras).

6) **Nineteen Years Yuga** [Seven sisters]

Basic period = 19 years (8+11)

Made up of one *over-corrected* eight year yuga and one *under-corrected* 11 years yuga.

Extra months	= 7 (3+4)
New/full moons	= 235
Yuga length	= 235 synodic months
Length of year	= 371 1/19 dyus
	= (365.19493703+.5180805) days
	= 365.24674508 days

[Discoverer : Dirghatamas, c. 2350 B. C.; most accurate 'observed' year].

7) **Thirty year Yuga** [Viswamitra]

Basic period	= 30 years
Extra months	= 11
New/full moon	= 371
Length of Yuga	= 371 synodic months
Length of year	= 371 dyus

Note :— From this is derived the theoretical Vaiswamitra Yuga of 3339 dyus : This gives simultaneously :—

1) Year 365.19 days
2) Eclipse cycle 223 months
3) Precession of 45° (an octant or Vasu) 3339 parivatsars

= 3,240 years[1].

Discoverer Viswamitra School : Dirghatamas, Viswamitra II and king Bharata established the year beginning at the autumnal equinox at Kritika *Purnima* in *c*. 2.350 B. C.].

With these basic ideas about pre-vedic astronomy, one may proceed to look into the Vedic age, beginning from 3100 B. C. This will be discussed in Vedic Astronomy separately.

(1) Please see A. I., p. 137, for an eulogy on the greatest astronomer of the ancient world.

TABLE

Luni-Solar Calendars

Observed				Calculated						
Yuga				(Daily Rising Calculated)			Year	Sidereal Revolution		
No.	Years	New full moons	Extra month	Sun	Star	Tithis	(Lunar) Tithis	Sun	Moon	Name
1	1	12+	—	365+	366	360	360	1	13	Viswedevas
2	3	37+	1	1,095+	1098	1110	370	3	40	Vamana-Vali
3	5	62 -	2	1,830	1835	1860	372	5	67	Pitamaha Bhisma
4	8	99	3	2,922	2930	2970	371¼	8	107	Vasus
5	11	136	4	4,017	4028	4080	370 10/11	11	147	Rudras
6	19	235	7	6,939	6958	7050	371 1/19	19	254	Matrikas
7	30	371	11	10957+	10987+	11,130	371	30	401	Viswamitra I

Of them, the five years yuga (Pitamaha Bhisma) and the thirty years yuga (Viswamitra) were theoretical i. e. they were used for calculation and prediction. The others, particularly, 4) and (5) i. e. 8 year & 11 year yugas were observational and actually used. Eight years were called Vasus and eleven years were called Rudras. The succession of Eight-year yugas and Eleven-year yugas, automatically gave the correct 19 year cycle.

VI Elementary astronomy and precession

Nakshatras

For any kind of observational astronomy, a system of reference frame in the sky is essential. In the ancient days, it was particularly necessary to describe the position and the phases of the moon, because the moon was their prime indicator of time — the moon being the maker of the months for the ancients. Naturally, the bright stars on the path of the moon was selected for reference because the moon's postion and phase was easily seen and marked against the background of these *fixed* stars. Bright stars like Aldebaran, Betelguse, Regulus, Antares etc, were chosen, because, being near the ecliptic, they easily marked the daily position of the moon. It was soon found that 27 or 28 stars were needed because the moon completes one revolution in about 27½ days.

What distinguished the ancestors of the Vedic Aryans was that they marked very carefully the position of the full moon and new moon among these stars. They noticed the step-like motion of the full moon i. e, that the successive full moons occured at different stars and that there was about 12 (groups of) stars which marked the twelve full moons necessary to complete the year.

The twentyseven bright stars ultimately chosen as the frame of reference were called the *nakshatras*. The position

of the moon was described with reference to them e. g "Today the moon is at Aldebaran, day after tomorrow, it will be at Betelguse, and so on".

Besides this method, the phases of the moon were also used to mark the day. The full moon (from one full moon to another) was divided in 30 equal units of time, and each division was called a *dyu*. The ancients knew that a day (solar day) was different from a *dyu*, and that 59 days were required to complete two synods of the moon. Thus, two lunar (synodic) months equalled 59 days and the period was equal to 60 *dyus* (60 *dyus* = 59 days)

Further, the ancients had an year of 12 synodic months i.e., twelve full moons. In this book, this year has been called the 'ancient year' or the '*parivatsara*'.

The importance of the nakshatra system is that it is a siderial (star-based) system and, being invariant, is admirably suited for chronological computations : whenever there is a full moon or a new moon at a nakshatra, the sun's position is automatically known in an invariant frame of reference, and, hence, the precession can be worked out accurately.

Mathematical

The plane in which the sun moves round the celestial sphere, cuts it in a great circle which is called the ecliptic, or the sun's path. The axis of the ecliptic (the straight line through the centre of the earth and perpendicular to the plane of the ecliptic) pierces the celestial sphere at two points called the poles of the ecliptic. The celestial sphere is mapped out with respect to the ecliptic and the ecliptic poles by longitudes and latitudes in exactly the same way as the earth is mapped.

The axixs of the earth's daily spin is inclined to the axis of the ecliptic at an angle of 23 1/2 degrees. The axis of the spin, when produced also meets the celestial sphere at two points called the poles : the whole celestial

sphere spins on this polar axis daily. The plane in which the earth's equitorial plane cuts the celestial sphere is a great circle which is called the equator of the celestial sphere. The stars are also mapped out on the celestial sphere with reference to this celestial equator and the equitorial poles in terms of coordinate known as the hour angles and declination.

The equitorial plane is inclined to the ecliptic at an angle of about 23½ degrees, this being the inclination of the earth's axis to the plane of the ecliptic. The equitorial plane cuts the ecliptic at TWO points called the equinoxes. When the sun reaches any of these points, it rises exactly due east-West. The two points at right angles to the equinoxes are called the points of solstices, and the days and the nights are the longest there. These four points are the cardinal points of the ecliptic on the celestial sphere, and are defined as follows :

Vernal equinox	0°
Summer solstice	90°
Autumnal equinox	180°
Winter solstice	270°

These cardinal points slowly advance in the ecliptic, completing one revolution in about 25,920 years. This motion is called the precession.

It should be remembered that in observational astronomy it is said that the sun moves round the earth in one year i. e. the geocentric language is used even though the astronomers know full well that the movements are helio-centric.

Pole star

The axis around which the earth spins daily, is pointing to the sky, and, when projected, it meets the celestial sphere at a point called the pole. If there is a star at that point viz the pole, it would appear to be a fixed star and would be called the 'pole star'; and the whole sky will appear to revolve round this polar axis. As the axis of earth's spin rotates slowly in the heavens, the

equinotical pole would describe a small circle (the polar circle) once in about 26,000 years around the pole of the ecliplic. There are bright stars (stars up to the third magnitude are easily visible) on this polar circle and, in distant epochs, these bright stars successively become the pole stars. The following stars became polar stars in distant epochs as shown below :

1. 12400 B. C............................Vega (Daksha) (a-Virginins)
2. 4700 B. C............................i-Draconis
3. 2800 B. C............................a-Draconis
4. 1300 B. C............................k-Draconis
5. 2000 B. C............................a-Ursa Minoris (Dhruva or the present pole star)

(There were no pole stars, in between these epochs.)

I shall not be far wrong if I say that I am 'seeing' that in c.13600 A. D., there will be a very bright pole star viz. the Vega. The ethnologist and the anthropologist, on the other hand, may search his records to find whether Magdellanean left any trace of a bright pole star in some painting of 12400 B. C, (This is why the rishi (the seer) is called *TRI-kala-Darshi* — one who 'sees' the past as well as the future.)

Whenever there is a visible pole star, astronomical observations become simpler. It is perhaps for this reason that the astronomical consciousness of the prehistoric man was heightened at these epochs. There were indeed interesting observations both around 4700 B. C. as well as around 2800 B. C. and I leave it to the interested readers to work them out.

The readers should remember that these bright stars were milestones in prehistoric chronology and they should be on the lookout for astral symbols when digging up the remains of these periods.

Precession

There is a grand cosmic clock in the high heavens whose invisible hand turns once in 26,000 years. Those who can read it, can read the past with unerring accuracy. For, the sun and the moon will testify to what they say.

That is the clock of precession : What is precession ?

Newton showed that the direction of the earth's axis of spinning is not fixed in space but that it slowly rotates around the axis which is pointing to the pole of the ecliptic, completing one rotation once in about 26000 years — the exact rate of rotation being one degree in 72 years, or 50" per year.

This rotation of the axis has an effect on the seasons, because the beginning of a season is determined by the direction of the earth's axis in space. Due to this slow rotation of the axis, therefore, the seasons also slowly advance. If the winter solstice is taking place on 21st December now, it *will* take place on 20th December after 72 years and it took place on the 22nd December in the past — 72 years ago. Once long ago, it took place on the 1st of March which means an advance of 70 days (10 days of December plus 31 days of January plus 28 days of February plus one day of March). Hence there is an advance of 70 days which took about 5040 years. This means that the epoch when the solstice took place on the 1st March was about 3070 B. C. (expressed as *circa* 3070 B. C. or c. 3070 B. C., for short.) Knowing the date of the equinox or the solstice, the epoch can, therefore, be easily calculated.

The rotation of the earth's axis has another effect. Suppose the sun was at the celestial longitude of 280 degrees when the winter solstice took place. It will take place at the longitude of 270 degrees after 720 years because the rate of advance of celestial point of the solstice is 72 years per degree. The bright stars have fixed longitudes. Knowing the longitude of the star at which the equinox (or solstice) occurred, the epoch when it so occurred can be easily calculated.

The advance of seasons can, therefore, be measured in two ways : by days or by degrees. It so happens that the sun advances approximately by one degree in one day, because it revolves round the ecliptic once in a year : (the exact rate is of course, 360

degrees in 365.25 days). Hence, in broad calculation — like what is needed for prehistoric chronology — the rate is taken either at one day per 72 years or one degree per 72 years. When exact data is available, more accurate computation can be made, but such accuracy is hardly ever necessary for prehistoric chronology.

It should be particularly remembered that point of equinox in the sky is invisible, and, similarly, the, point of the solstice is also invisible. The hands of the cosmic clock are invisible and only the 'seer' sees them.

The equinox and the solstice today is defined as follows :

Vernal equinox — 21st March or 0° of celestial longitude

Summer solstice — 21st June or 90° of celestial longitude

Autumnal equinox — 21st Sept. or 180° of celestial longitude

Winter solstice — 21st Dec. or 270° of celestial longitude.

These days are of crucial significance because the calendars are set thereon. These four days are called the cardinal days of the year and these four points will be called the cardinal points of the ecliptic. The new year begins at one or other of these days or points. What is of great significance to the ethnologist or the anthropologist is the fact that *all important festivals and rituals of prehistory are linked with one or other of the points or days.* Thus, in India, Vagdevi (the goddess of learning) is worshipped on *Magha Shukla Panchami* (i. e., the fifth day of the white fortnight of the month of lunar *Magha*). Winter solstice once took place there, and on that day, Vak announced her celebrated Davi sukta, because it was an auspicious day. Usually, an auspicious day was one of the cardinal days. By a proper analysis, the origin of many festivals and rituals can be determined.

Incidentally, all the prehistoric calendars were lunar because the moon was then the maker of the months. It is very difficult to determine the day of a lunar month in terms of a solar calendar because a lunar month advances by about eleven days in a year and

synchronisation is restored by adding one extra month in the third year, the process being called intercalation. It is only for this reason, that the chronology of ancient history is so difficult. The rule is to ensure that the original reference was to a standard year, by ascertaining that the full moon took place exactly at a particular nakshatra which was the star of reference. Unless one makes sure of this correction, dating should not be attempted: Failure to keep this in mind will lead to absurdities.

Determination of cardinal days and cardinal points by observation

How were the cardinal days and cardinal points of the sky actually determined by observation ?

Great importance was attached to these days and their corresponding celestial points. In the Vedic terminology, they were connected with the word *ritam* (root *rit*) : thus, the equinox was called '*Ritasya Yoni*' — the fount of ritu or season ; '*ritasya sadanam*' — the house of rita; '*sukritasya yoni*' — 'the fount of good works', because the good work of the year began with it. The guardian of the point was called '*ritasya gopam*' — 'the guardian of rita' : all these points were situated in the heavens i. e. in the celestial sphere. Thus, in the very first hymn of the Rigveda it is said that AGNI (— Fire) is the guardian of ritam. It apparently means 'Fire is the guardian of the cosmic law of the world', a statement which is not very intelligible. However, its astronomic or cosmic sense is clear because — astronomically Agni means Alcyon (see Table I). The hymn therefore, means that 'Alcyon (AGNI) is the guardian of the Ritam' or the guardian of the cardinal point of equinox in the heavens, which is perfectly meaningful. From this fact alone, the date of the hymn can be calculated to c. 2400 B. C. As the observations were crude and correct to say, 3 degrees (or 3 days), the epoch can be ascertained to about ± 200 years.

The importance attached to these days being obvious, their determination is now explained.

For calendar making, these days are defined as follows

Sunrise due exact east = equinox

Sunrise at the nothernmost point of the horizon = summer solstice.

Sunrise at the southernmost point = Winter solstice

It is easy to know the midwinter by its general acuteness but it is difficult to determine the exact day of solstice. This is so, because the sun remains stationary there for about TEN days. On the other hand, the movement of the point of sunrise at equinox is very easy to discern, because it is very fast, being about 23 minutes of an arc per day. With a little practice and care, the equinox can be determined to within a day. The precautions are as follows :

1. Select a point of observation from which the eastern horizon is clearly visible : It should be a distant horizon.

2. The point of observation should be fixed. A small rostrum *(vedi)* is useful, so that the observation is necessarily made from a fixed point. In the Rigveda, this rostrum *(vedi)* was called the centre of the universe. This shows *inter alia*, that the Vedic astronomy was basically geo-centric as all observational astronomies are.

3. If possible, a distant marker should be selected. It aids observations.

4. Finally, when the east point is known (by successive observations covering three or four or more years), the position of the eye should also be fixed precisely. This is secured by raising a small platform or stone or pole over which the eye is placed. An observation is facilitated by having a second pole or platform with a marker thereon. This mode of observation is seen in the stonehenges which were ancient sun temples i.e. observatories.

Once the problem is known, the observer will himself devise his own methods and his aids to determine the *exact* east point. From Dirghatama's hymn, we know that this point was worshipped as Hotu — the invoker. (See Appendix I, Part II).

5. Help was taken from other sources also. When the true East was found, one looked for the star which rose at that point on

* equinox : equi = equal ; nox = night; i.e. when the night and day are equal

the horizon. If a true East star was found, it could be used to directly determine the east direction. Thus, Krittika was declared to be the East star, and it was used by all: the architects, for instance, used the rising of the Krittika to determine the direction in whicn the main shaft of a building *(Shala)* was to be laid. Unlike the sun, the East star rises at the East point, throughout the year. It never moves. However, like the pole star, the East star also is shifting slowly.

Having determined the true east, the astronomers (who were called the *nakshatradarshas*) took great care in ascertaining the *tithi* (i. e. the lunar day) at which the sun rose exactly in that direction. That was in fact, the main observation, and, when determineed, it was declared to be the tithi of the equinox. However, the astronomers knew that tithi would truly disclose the equinox only in a true year (*samvatsara* ; sam — true; *vatsara* — year). If it was a *purnima* (i.e. full moon), it assumed great importance because it also automatically fixed the bright star of the equinox if one happened nearby. Thus, in c. 2350 B.C. Krittika was declared to be the autumn star by Dirghatamas and Viswamitra II, because they found that when there was a full moon at Krittika it was the true equinox. The determination of the tithi or the nakshatra was not an easy task. It took years of patient watch.

Vedic seers knew that different stars became autumn stars at different epochs. Thus, they knew in 2400 B.C., that although Agni was the then ruling autumn star, centuries ago Prajapati (Rohini) was doing the function. They also knew that Soma, Rudra, Daksha, Aditi* were the autumn stars at distant past epochs.

An observatory

A student who seeks to a open a small observatory like what the Vedic people used, should first identify a few bright stars (i. e., the *nakshatras*) with the help of some astronomer friend. In case such a friend is not available, he should try to learn the structure of the group '*Kalapurusha*' (or the group 'Orion'). On the head of the group (i.e. looking towards the North from left to right i.e. from

* Soma = L-Orioniss; Rudra = Betelguse; Daksha = Vega and Aditi = Pollux.

west to east, the two bright stars are respectively called Mrigashiras (L-Orionis) and Ardra (Betelguse) Towards the left of Mrigashiras i.e. to its west, is a pretty red star shining like a gem — the Rohini or Aldebaran. He should pick up these three stars of the first magnitude carefully — Aldebaran, L - Orionis and Betelguse — because a preliminary beginning in the study of the ancient astronomy can be initiated with their help alone. If the moon is at Aldebaran on the first day, it will be at L - Orionis the second day and at Belegues on the third day.

Some other important stars (not groups but individual bright stars) are given below :

Aldebaran ....Rohini
L - Orionis.................Mrigasiras (stag's head)
Betelguse...................Ardra
Sirius.......................Soti or Sothes (Egypt) or Lubdhak
Pollux.......................Punarvasu
Regulus.....................Magha
Arctauras...................Svati
Antares......................Jyestha or Jyestha Rohini
(antepodic to Rohini)

and, finally Krittika (= Alcyone) which is at right angles to the easily recognizable Regulus. When Magha is rising, Krittika is at the mid-heaven : wnen Krittika is setting, Magha is in the mid - heaven. The student should identify them all in the sky with the help of a star map giving their European names, because they are essential for chronology.

A full list of the bright stars with their modern nomenclature, magnitude, colour classification and position (in hour angle and declination) is given in the Table I. A corresponding list giving the Indian names and the deities (i.e. the Rigvedic or prehistoric names) is given in table II. This table also gives the longitudes with reference to the ecliptic, for the base year 1970 A D. They can be used directly for chronological purposes because the rate of precession is 72 years per degree with respect to this frame.

Finally, in Table III is given the days (approximate only) when the full moon and the new moon occur at particular nakshatras in the base year 1970 A.D. They will help one to spot the nakshatras in a *samvatsara* or perfect year.

Observations :

1) Observe the moon each day (at a fixed time, say after sunset) and note the bright star nearest it. Try to recognise the nakshatras with the help of table II. The moon goes from one nakshatra to the next (about 13°) in one night. After some practice, say for one or two months, try to visualise — to see — the sun, the moon and the nakshatras *all the time*. Very soon, you will carry the entire nakshatra circle in your head. You will be able then, to 'see' the moon, perhaps below your feet : Next, you will 'see' the star near the sun even at mid-day. Only when you 'see' them — will you enjoy the Vedic astronomy, because you begin to be a *rishi* — a seer.

2) Watch the sunrise and the sunnset daily. For this purpose, select one spot and erect a small rostrum (- *vedi*). The east direction should be clear with the horizon about 6 miles away, if possible. The sunrise should be marked with the help of markers on the horizon. Finally, carefully mark the extreme positions and observe how many days it takes for the sun to turn i.e. how many days the sun stands still (Sol — sun; stice — standing). Set up two markers on the horizon — one on each of these extreme points.

Finally, *with utmost care*, mark the mid-most point. This will define the true east, and, on the equinox day, the sun will rise at that point. Is any star rising from that point ? If there is such a star, it will always rise there — wherever you be on the earth, and whatever be the day of the year.

3) Watch the seasons also simultaneously; Watch the seasons, the birds, first flower, the first fall of leaves. Watch the day of appearance of some migratory birds, if they halt on any lake nearby.

Watch the first rains. In short, study nature and all the indicators of seasons (*ritu lingas*) and record them with dates, at least for six years.

4. Very carefully observe the bright star (— nakshatra) at which (a) the full moon and (b) the new moon occurs from month to month. Record the dates and the nakshatras. Have you observed that the full moon has a step-wise motion among the circle of the bright stars ? Can you name the month from the nakshatra of the full moon ?

5. The records should be in such a form that your students or successors can use them.

Tests to mark progress :

1) As soon as a student is able to make the 'intercalation independently, his apprenticeship is over. He should independently determine the length of the year in terms of the lunar day (*dyu* or *tithi*).

2) He should independently determine the day of the enquinox. If he can determine the tithi of the equinox in a standard year, he is a graduate in lunar astronomy. Let him then declare the *tithi* at which the year should begin.

3) When he can predict a lunar eclipse on the basis of his own observations he is a master. Can he predict the total solar eclipse ? If not, why not ?

4) He should then analyse the past observations mentioned in the ancient legends; and try to decipher the phenomenon recorded in simple symbols in the Rigveda. If he can determine the rate of precession therefrom, he is grand master.

5) Finally, firmly fix a long tube (say two or three cubits in length) and let it point to a bright star (like Serius or Regulus). It is called a *nalika* or *nal*. Can you, or can you not, correct the chronometer of your friend with its help ?

(Greenwich telescope is nothing but a sophisticated *nal)*

TABLE I

NAKSATRA LISTS

(See Indian Ephimeris - 1958)

	Name of the star	Presiding Deity	Longitude in 560 A.D.	Position in 1956 as given in Indian Ephemeris		
				Magnitude colour	Hour Angle	Declination
1	2	3	4	5	6	7
			Dog.		Hr - Min	Deg.
1.	*Krittika* *ALCYONE* 139 Tauri	Agni	39.07	2.96 / B	3 - 45	+ 24
2.	*Rohini* *Aldebaran* 168 Tauri	Prajapati or Brahma	49.75	1.06 / K	4 - 33	+ 17
3.	*Mriga S'iras* Orionis	Soma (Candra)	63.67	3.66 / 0	5 - 33	+ 10
4.	*Ardra* *Betelguse* 224 Orionis	Rudra	68.71	0.10 / M	5 - 33	+ 7
5.	*Punarvasu* *Pollux* 295 Geminorum	Aditi	93.23	1.21 / K	7 - 43	+ 28
6.	*Pusya* 326) Cancrii	Vrhaspati	108.70	4.17 / K	8 - 42	+ 18
7.	*Aslesha* Hydrae	Sarpa	112.33	3.48 / F	8 - 45	7
8	*Magha* *Regulus* 380 Leonis	Pitri	129.81	1.34 / B	10 - 06	+ 12
9.	*Purva Falguni* 422) *Leonis* Zosma	Bhaga	141.25	2.58 / A	11 - 12	+ 21
10.	*Uttara Falguni* 422) *Leonis* Denebola	Aryama	151.61	2.53 / A	11 - 46	15

1	2	3	4	5	6	7
11.	*Hasta* 465 *Leonis* Corvii	Savita	173.45	3.11 / A	12 - 28	- 16
12.	*Citra* *Spica* 498) Virginis	Tvasta	183.81	1.21 / B	13 - 23	- 11
13.	*Svati* *Arctaurus* 526) Virginis	Vayu	184.20	.24 / K	14 - 14	+ 19
14.	*Visakha* 559) Librae	Indragni	211.00	4.66 / A	13 - 10	- 20
15.	*Anuradha* 597 Scorpionis	Mitra	222.57	2.54 / B	15 - 58	- 21
16.	*Jyestha (Rohini)* *Antares* 616 Scorpii	INDRA	229.73	1.22 / M	16 - 27	- 26
17.	*Moola* 652 Scorpio	Nirriti	244.55	1.71 / B	17 - 31	- 37
18.	*P. Ashada* 687) Sagittarii	Apah	254.33	2.84 / K	18 - 18	- 30
19.	*U. Ashada* 706) Sagittarii	Visvedeva	262.35	2.14 / B	18 - 53	- 26
20.	*Abhijit* *Vega* 699) Lyra	Daksa	265.25	.14 / A	18 - 35	+ 38
21.	*Sravana* *Altair* 745 Acquila	Vishnu	281.68	.89 / A	19 - 49	+ 9
22.	*Dhanistha* 771) Delphinis	Vasu	296.31	3.72 / F	20 - 36	+ 14
23.	*Shatabhisaj* 864) Aquarii	Varuna	321.55	3.84 / M	22 - 50	- 8

1	2	3	4	5	6	7
24.	*P. Bhadrapada* 871) *Pegasii ??* Markab	Aja-Ekapad	333.45	2.57 / A	23 - 02	- 15
25.	*U. Bhadrapada* 1) Andromeda ?	Ahir-Budhnya	349.13	2.15 / A	0 - 06	29
26.	*Revati* Piscium ?	Pusha	359.83	5.57 / A	1 - 12	+ 7
27.	*Asvini* 66) *Arietis* Sheraton	Asvinau (Nasatya)	13.93	2.72 / A	1 - 52	+ 21
28.	*Bharani* Muscae	Yama	26.90			

Some other important stars outside the Naksattra system are

1.	*Brahma Hridaya* *Capella* Auriga	.21 / G	5 - 14	+ 46
2.	*Dhruva* *Pole Star* Polaris	2.12 / F	1 - 14	30
3.	*Agastaya* Canopus	.86 / F	6 - 23	- 53
4.	*Sothes* *Sirius* Canis Major	1.58 / A	6 - 43	- 17
5.	*Abhijeet* *Vega* Lyra	.14 / A	13 - 43	+ 38

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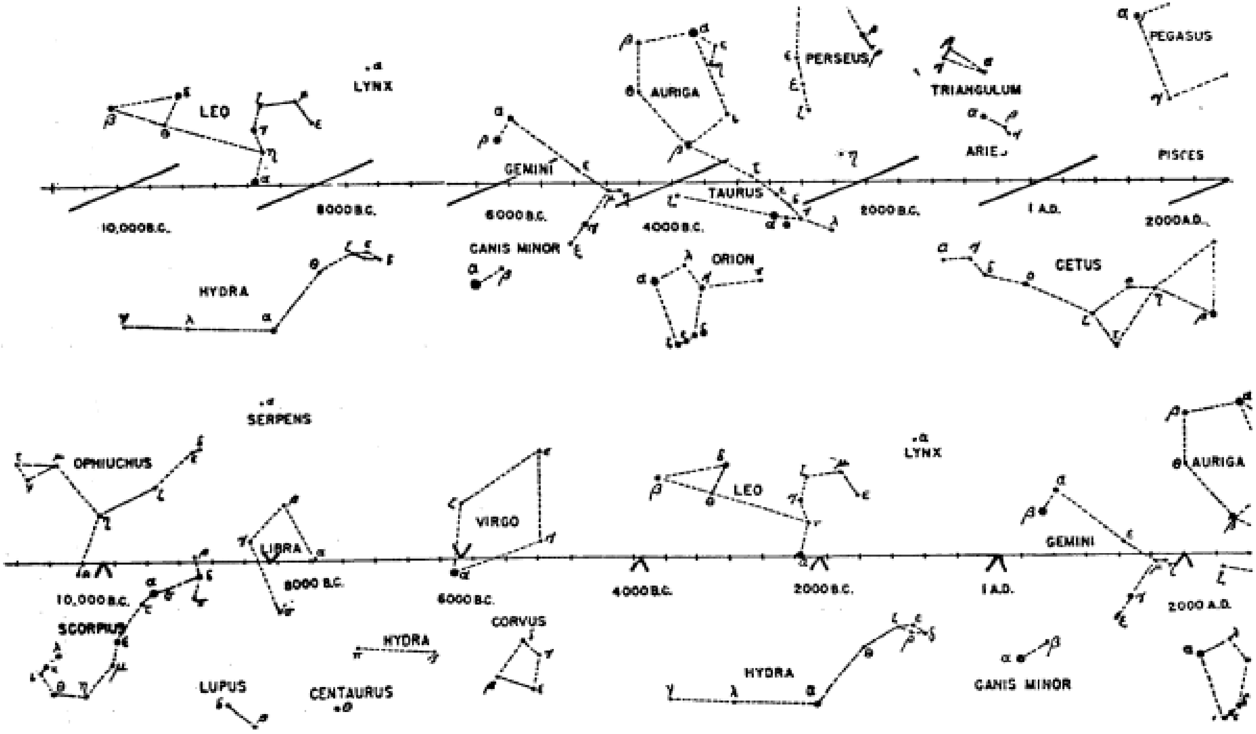
TABLE II

APPROXIMATE TABLE OF PURNIMAS IN 1970 A. D.

(For quick computation)

Degrees (Longitude)		Purnima on	Amavasya on (i. e. sun at)
60	Krittika	20th Novr.	20th May
70	Rohini	30th Novr.	30th May
83	Mrigsiras	14th Decr.	14th June
88	Ardra	19th Decr.	19th June
90	Daksinayana..........................	21st June	
	Punarvasu		
	Pushya		
	Aslesha		
150	MAGHA	21st Feb.	21st Aug.
161	P. Falguni	1st March	1st Sept.
171	U. Falguni	11th March	11th Sept.
180	Sharad Vishuva..................	(21st Sept.)	
203	Citra	14th April 1st Vaisakh	14th Oct.
203	Svati		
230	Visakha	14th May	11th Novr.
	Anuradha		
250	Jyestha Rohini	1st June	1st Decr.
270	Uttarayana.........................	(21st Decr.)	
274	P. Asada	24th June	24th Decr.
282	U. Asada	6th July	6th Jan.
285	Abhijeet	9th July	9th Jan.
301	Sravana	21th July	21st Jan.
316	Dhanistha	5th Aug.	5th Feb.
341	Satabhishaj	2nd Sept.	2nd March
353	P. Bhadrapada	14th Sept.	14th March
360	Vernal Equinox..................	(21th March)	
8.5	U. Bhadrapada	29th Sept.	29th March
19	Revati	11th Oct.	11th April
[21]	(Asvini's beginning)	13th Oct.	13th April
33	Asvayuja (nasatya)	21st Oct.	21st April

Star Map



This is the ecliptic star map of relevant stars showing the Precession of the equinoxes (top half), and of the solstices (bottom half).

TABLE III

NAKSHATRAS

Base year 1,970 A. D.

Sl. No.	Nakshatra	Deity	European	Longitude	No.
1	2	3	4	5	6
1.	Krittika	Agni	Alcyone	59.54	1.
2.	ROHINI	Prajapati	Aldebaran	69.32	2.
3.	Mrigasiras	Soma	Orionis	83.24	3.
4.	ARDRA	Rudra	Betelguse	88.28	4.
5.	PUNARVASU	Aditi	Pollux	112.88	5.
6.	Pushya	Brihaspati	Cancrii	128.27	6.
7.	Ashresha	Sarpa	Hydrae	131.90	7.
8.	MAGHA	Pitris	REGULAS	149.38	8.
9.	Purva-Falguni	Bhaga	Zosma	160.82	9.
10.	Uttara-Falguni	Aryama	Denebola	171.18	10.
11.	Hasta	Savita	465 Corvii	192.97	11.
12.	Citra	Tvasta	Spica	203.38	12.
13.	Svati	Vayu	Arctaurus	203.77	13.
14.	Visakha	Indragni	559 Librae	230.57	14.
15.	Anuradha	Mitra	597 Scoprionis	241.84	15.

1	2	3	4	5	6
16.	JYESTHA-ROHINI	INDRA	ANTARES	249.30	16.
17.	MULA	Nirriti	652 Scorpionis	264.18	17.
18.	P. Asada	Apah	687 Sagitarii	273.90	18.
19.	U. Asada	Visve-deva	706 Sagitarii	281.92	19.
...	ABHIJEET	DAKSHA	VEGA	284.82	...
20.	Shravana	Visnu	Altair	301.25	20.
21.	DHANISHTHA	Vasu	Delphinis	315.88	21.
22.	Shatabhisaj	Varuna	864 Aquarii	341.11	22.
23.	P. Bhadrapada	Aja-ekapada	Markab	353.02	23.
24.	U. Bhadrapada	Ahi-Budhna	Andromedae	8.70	24.
25.	Revati	Pusa	Piscium	19.40	25.
26.	Asvini	Asvinau	b. Arietis	33.50	26.
27.	Bharanis	Yama	a. Muscae	46.47	27.

Notes : 1. The identification is due to Colebrooke and Jacobi.

2. In computations, the longitudes have been rounded off to the nearest multiple of five; and, only simple, approximate, first order calculations have been used to emphasize the approximate nature of the original observations. The accuracy of the dates is correct to only $\pm$ 200 years. (i. e., within three tithis or three degrees or three days). Higher accuracy in computations is, therefore, pointless.

3. Ayanamsa in 1,970 A. D. is 23.490 (Approx.)

VII

Transition from prehistory to protohistory - 3100 B.C.

This section on the prehistoric lunar astronomy may now close. However, before doing so, a brief reference may be made to the transition to the protohistory.

Protohistory is separated from prehistory, when one comes across some tangible *contemporaneous* material in addition to the legends and traditions. In the Rig Veda, one gets a book which has come intact, word for word (every word counted) after being compiled by Vyasa in c. 1400 B. C., as explained by Roy[1] It is like a huge stone inscription of c. 1300 B. C., which carry the most ancient traditions of humanity, and, therefore, with the Rig Veda, one comes to protohistory.

In the Rig Veda, one comes across one hymn composed by Nabhanedishtha, the son of Manu Vaivasvata, which has been translated by Wilson (2)as follows :

R. V. 10.61.6. "When the deed was done in the mid-heaven in the proximity of the father working his will, and the daughter coming together, they let lose the seed fall slightly, it was found upon the high place of sacrifice."

This is apparently an incestuous sexual union between a father and daughter, and Griffith (3) felt it to be untranslatable. He commented on the whole hymn as follows :

'This hymn, as Ludwig observes, belongs to the most difficult, one might say

almost the hopeless portions of the Rig Veda. It is made up of several parts which has no intelligible connection with one another.'

The hymn belongs to the particularly unintelligible portion 5—9, and Griffith said of them :

"I pass over stanzas 5—9, which contain an ancient legend, probably the later story of Brahma or Prajapati and his daughter, concerning two deities or powers of nature."

The obscurity is due to two factors : Firstly, because of its extreme antiquity — the hymn going as far back as to 3100 B. C., as will be presently shown; secondly, because it is purely astronomical, and, unless one knows the Vedic lunar astronomy with its esoteric terms, its meaning cannot be deciphered. Further, a proper comprehension requires constant observation of the Rohinis, and their full moons — i. e., actual observation of the sky.

The quaint symbolism of the hymn attracts immediate attention, and there are commentaries on the hymn from the earliest times. A hymn by Dirghatama (c. 2350 B. C.) alludes to the phenomenon(4). The Aitareya Brahmana(5) (c. 1450 B. C.) and the Shatapatha Brahmana(6) (c. 1400 B. C.) concedes its astronomieal significance, and explains that it relates to Prajapati and his daughter Rohini. From the details given in the Taittiriya Samhita(7) c. 2300 B. C., and continuously followed later, Colebrooke identified Rohini as the star Aldebaran (a. Tauri). and this identification is now universally accepted.

Sayana in his commentary (c. 1400 A. D.), concedes its astronomical significance, but his meaning is forced, because he had no knowledge whatever of observational astronomy : his interpretation merely seeks to white wash the legend, without shedding any light either on the phenomenon or on the imagery.

In modern times, Weber and Whitney noticed the hymn. Weber(8) noticed the connection between *'Rohini'* (Aldebaran) and its antepodic star Antares — also called Jyeshtha *'Rohini'* — and

suggested that they were connected with the equinoxes. Whitney haughtily rejected the idea in his usual strong language and asserted that they were both called the Rohinis merely because they were both red. (for a full account please see ref. 8). He firmly denied any further connection or significance. Whitney,(9) however, conceded that it was an astronomical hymn. He, felt that Prajapati was Orion though he did not give any reason for this indentification.

He writes :

'...there is the whole story illustrated in the sky; the innocent and the lovely Rohini (Aldebaran); the infamous Prajapati (Orion) in full career after her...'

But why is Prajapati identified with Orion? Is there *any* authority, ancient or modern, for the identification? Is it not a pure *ipsi dixit*? Is not the statement made with the fullest self assurance but without the whisper of any evidence? Is it not Whitney at his best — a beautiful portrayal, a picturesque and forceful language — but no material ?

Tilak next came in, and gave the following further information :

a. Prajapati means the year in Vedic literature (Prajapati is verily the *samvatsara*', (10). The assertion may be taken as proved and correct.

b. Prajapati begins the year. One may also readily agree with this interpretation, because Prajapati is the Lord of time and he begins time i.e. the year.

c. Following Whitney, Tilak further said that Prajapati was the Antelope's head i.e. the head of the star group Orionis. This assertion remains unproved, because of lack of authority.

(Orion is a star group and not a singal star) : Orion is the *Kalpurusha* of the Hindu legend.

One may now turn to other material which was collected over the years but whose relevance and significance was lost because no worker looked as the problem as a whole — from a distance.

Playfair,[11] the noted astronomer and mathematician, looked for the reason for starting the 'Caliyougham' (the famous Kali era of Hindu astronomy, which begins on the 16-17th February, 3102 B.C.) Following the earlier work of Bailly,[12] Playfair showed conclusively that it was connected with the vernal equinox at Aldebaran, later identified as Rohini by Colbrooke.

Finally, Pargiter[13] made a complete analysis of the *Vamsanucaritam* (dynasties) of the Vyasian Puranas a century later, in his classic Ancient Indian Historical Tradition, and worked out a complete table of *all* the successive kings from 1. Manu Vaivasvata to 96. Parikshit. He however did not accept the traditional date of the Bharata battle of 1424 B.C. (worked out by Cunningham — following the datum that 1015 years elapsed between the birth of Parikshit and the coronation of Nanda.)* Intead, he estimated the date (on the basis of admittedly incomplete post-Prikshita Puranas) at 950 B.C. Further, he totally refrained from making any estimate of the date of Manu Vatvasvata. Roy has taken the date of the battle at 1424 B.C. as proposed by Cunningham, and *adopting the same age differential or 18 years per king as taken by Pargiter himself to work out the date of the Bharat battle,* he arrived at 3149 B.C. as the probable date of birth of 2. Nabhanedishtha, the son of 1 Manu Vaivacvata, who composed the hymn under discussion (R.V. 10.61. 5-9)[14].

With all this material available in English, as the fruit of researches from 1800 A.D. to 1970 A.D., one may have a fresh look at the 'most ancient problem'. However, before attemptting a solution, one may refer again to some findings recorded in the present book itself. Firstly, one may reedily agree that Prajapati is the god of time : he is verily the year : he begins time i. e., he begins the year : that he is the equinox — for those who begin the year at the equinox. Secondly, the word *sukritasya yoni'*, 'the fount of the

* Cunningham,

good works' means the heavenly point of the equinox on the celestial sphere, because the good works of the year begins when the sun and the full moon are there.

One may now collect all the facts and commentaries at one place :

1. The hymn refers to some heavenly or astronomical phenomenon (all)
2. Nabhanedishta, the composer of the hymn, was the son of Manu Vaivasvata (Pargiter)
3. The date of birth of Nabhanedishtha, the composer of the hymn was c.3149 B.C. (Roy)
4. The daughter refers to Rohini (Attareya Brahmana, Shatapatha Brahmana)
5. Rohini is the star Aldebaran : Jyestha Rohini is the star Antares (all)
6. Rohini and her sister Jyeshtha Rohini are antepodic (Weber). To a star gazer *(vedic nakshatradarsha)*, one rises when the other sets : When the Purnima occurs at one, the sun is at the other.
7. Prajapati is the Lord of the year : He is the god of the new year's day (Tilak)
8. Prajapati is the god of the equinoxes which begins the year (Tilak)
9. There is no authority for Whitney's identification viz Prajapati (Orion). Even a close look at the sky does not reveal the connection (In fact, according to the Hindu way, Rohini *follows* Kalpurusha and not the other way about, as Whitney thought)
10. Kali Yuga, the epoch of the Hindu era, begins in 3102 B.C. (Bailly, Playfair)

11. The hymn refers to the equinox (Weber)

12. In c. 3100 B.C., the equinoxes took place at the Rohinis. (Playfair, Bailly)

13. In the hymn, the phrase *sukritasya yoni* meant the point of the equinox in the celestial sphere (Roy). It is here that the union took place and the seed fell. (A modern astronomer would perhaps say that exact conjunction took place here.)

One may now proceed to solve the puzzle. It is hoped that the reader has solved the problem by himself now; if not, he may read further :

As always, one needs a simple direct rendering of the hymn in such cases *plus* a direct look up at the sky : *"the riks are written in the high heaven — what shall he do with the earthly riks, he who does not know those heavenly ones ?"*

Translation : When the deed was done, the father and the daughter were united in mid-heaven, and the seed fell on the high place of the *sukritasya yoni.*'

Supplying the necessary astronomical touches in the brackets, the hymn reads 'When the father (Prajapati or the year beginning) and the daughter (the star Aldebaran or Rohini) was united in the mid-heaven (celestial sphere), at the high place of the sukritasya yoni (equinox) the seed fell.'

In other words it means simply : The equinox was at the Rohinis, when the year began.

The observation itself was extremely simple and a schoolboy could do it : *Whenever there was a full moon (or new moon) at a Rohini, it was equinox.*

To be more specific :

Date	Phenomenon observed	Result
30th Nov.	Full moon at Rohini (Aldebaran)	Autumnal equinox.
30th May.	New moon at Rohini (Aldebaran)	Vernal equinox.

30th May Full moon at Jyeshtha Rohini (Antares) Vernal equinox.

30th Nov. New moon at Jyestha Rohini (Antaras) Autumnal equinox.

As Rohini has a longitude of abont 69.5 degrees and Jyeshtha Rohini of about 249.5 degrees, the epoch of these phenomene can be easily computed at 3070 B.C.

It can be appreciated that the corresponding solstices will occur at 1st March (winter) and 30th August (summer), because the solstices occur about three months after the equ!noxes. (A system of calendar actully began the year at the solstices, the *ekastaka*, but it need not be considered now). The question arises as to why the Siddhanta astronomers took 16-17th February instead of 1st March for the beginning of their epoch. This question can be answered only when the Siddhanta astronomy and the method of transition thereto, is analysed at some length : This will be done in due order.

Before closfng, the reader is advised to theoretically work out the *tithi* of the equinoxes and the solstices today (base year 1970 :) and to determine by actual observation, the nakshatras at which they occur.

To sum up :

1. The hymn means that the equinoxes took place at the Rohinis.

2. The epoch of the phenomenon was c. 3070 B.C. (±200 years)

3. Nabhanedishtha, the son of Manu Vaivasvata, who composed the hymn was born, according to the dynastic chronology, in c. 3149 B.C. Hence, two totally independent methods suggest c. 3100 B.C. for the epoch of observation as well as for the date of the hymn.

The moral : By looking at the totality of the materials as a

whole — from a little distance — one sees the elephant where the others saw only the trunk, or the tusk, or the tail.

Reference :

1. Roy, Ancient India, a chronological study, 1500-400 B.C., (A. I.,) Delhi,1975, pp. 53 and 62 footnote.
2. Wilson, Rig Veda.
3. Griffith, Rig Veda, Vol. II, pp 465-6, and 611.
4. Dirghatamas, R.V. 1.164.33.
5. Aitareya Brahmana, III-33
6. Shatapatha Brahmana, II-1-2-8.
7. Taittiriya Samhita, IV-4-10
8. Weber, quoted and anaiysed by Whitney, Journal of the American Oriental Society, Vol. VIII, p.62.

"This usually has the name Jyestha, 'eldest', but in two of the most ancient authorities is also styled Rohini, 'the rudy'. Here again one can hardly help concluding that the second asterism is called the red for the same reason as the former one, and one may even accept the synonym as a welcome confirmation of the persistency of the asterism. Yet Weber apparently is not satisfied with an explanation so simple. He, on his part, takes note of the fact that the two stars in question are one hundred and eighty degrees apart ... very nearly, and that the former of them is in the Hindu traditions regarded as the special favourite of the moon; and upon these facts he proceeds to found a conjecture (which he then, in the next sentence, gives up again, as too utterly impossible), that the reason why the moon was once particularly loved Rohini was that the latter coincided with the vernal equinox (which would have been the case more than thirty centuries before Christ), and that the other Rohini was so called because, at the same period, it occupied the other equinox, and so headed the second half of the nakshatras, as the former Rohini the first half,"

(The solution was there but for the curtain of confusion raised by Whitney. The basic trouble was Max Muller's famous *ipsi dixit* : Rig Veda = 1200 B.C.)

9. Whitney, *Biot and Weber on the Hindu and Chinese Asterisms*, Journal of the American Oriental Society, Vol. VIII, pp. 51-53.

10. Tilak, Orion, footnote pp. 12-13.

10 (b). Tilak, *Ibid.* pp. 100-165.

11. Playfair, *Astronomy of the Brahmanas*, reprinted in Dharampala's Science and Technology in the Eighteenth century, Delhi.

12. Bailly, *Astronomie Ancienne*, quoted extensively by Playfair in the above.

13. Pargiter, Ancient Indian Historical Tradition, pp. 144-147

14. Roy, *Chronological Infrastructure of the Indian Protohistory*, Journal of the Bihar Research Society, Vol. Vol LVIII, 1972 pp. 56 *et seq*

and

Roy, *Comments on E. Baity's comprehensive review article, 'Archaeoastronomy and Ethnoastronomy today,'* Current Anthropology, Oct. 1973, pp. 436

Appendix : Creation Eras.

Many ancient nations used to count their dates from a supposed date of creation. The most ancient and the most important of them, take a date near 5500 B. C. as their era. Four of them are as follows :— (See James Prinsep, Useful Tables, P. 137-8 : Prinsep relied on Warren's Kala-sankalita, a book not available now).

Era of Constantinople :—

The era of 'creation' is placed at 5508 B. C. It was also used by the Russians until the time of Peter, the Great, and is still used by the Greek church.

Era of Antioch :—

The Christians following this calendar considered the date of creation as 5492 B. C. It was used up to 285 A. D.

Era of Alexandria :—

This is related to the above but they considered, the epoch of creation to be 5502 B. C. In 284 A. C., ten years were discarded and it was merged with the era of Antioch.

Abyssinian era :—

The Abyssinians reckon their years from creation, which they place in the 5493rd years before our era.

Thus all the four eras seem to be related to and centre round 5500 B. C.

Now, the Daksha-Sotee system began at about that time (vide, p., 16, *supra*). According to Hindu Puranas also, Daksha Prajapati was one of the creators of the universe.

Hence, it appears that it was a genuine ancient calendar in actual use in the ancient world, at least, in Russia, Greece, Egypt, Abyssinia and India.

It would, therefore, be of some interest to calculate the epoch of Daksha-Sotee system a little more accurately than has hitherto been done.

		Long.	Precession
Daksha	=	284.8	104.8
Sotee	=	103.9	103.9

Taking the average, the precession comes to 104.3 degrees which gives a time lapse of about 7510 years upto 1970. This gives the epoch of 5540 B. C.

It is, therefore, clear that the era of c. 5500 B. C. — extensively used in the ancient world — was a 'real' era commencing when Daksha-Sotee i.e. Vega-Sothes (the brightest stars of the northen and the southern sky) was jointly used to determine the equinoxes.

Further, if this was a 'real' era in use, then its giving up must also have caused consternation among its users and hence, there must be some considerable truth in the legend of *Daksha-yajna-bhanga* (i.e. the break up of the Daksha cycle), and the establishment of Shiva (Betelguse) in c. 4400 B. C. as the autumn star.

Similarly, there is a Christian belief that the Creation occured 4004 years before the Christ. This 'creation' was perhaps related to the installation of Soma (L-Orionis) as the autumn star. The longitude of L-Orionis is 83.24 degree. Hence, the epoch works out to 4023 B. C,

One, therefore, has the following data :—

	Era	Equniox	Date
Ancient era	c. 5500 B. C.	Vega-Sothes	c. 5540 B. C.
Christian era	c. 4004 B. C.	L—Orionis	c. 4023 B. C.
Hindu era	c. 3102 B. C.	Aldebaran	c. 3070 B. C.

In other words, 'Creation' in ancient texts, would appear to mean in modern terms, the creation of a fresh epoch of a new era of astronomy.

AS FAR BACK AS THE MIND CAN GO

VIII

Dawn of Civilization

Preliminary

This section intends to give the scientific background in which the history of man unfolded. It is, by its very nature, speculative and descriptive : It cannot be more, in the present state of knowledge.

It seeks to give firstly, a scientific picture of the different stages of culture so far worked out by the geologists, archaeologists, ethnologists and scientists by applying modern scientific methods.

It then seeks to give the story of the birth of sciences, viz., the birth of fire, tools, and speech and astronomy.

A scientist has been defined to be a person who can measure and count, and thus to predict the future. We have tried to imagine how the cave-man learnt to measure and count.

As the book is not confined to the country within the borders of the Himalayas, a complete grasp of the story told will be secured only when the background of prehistory of the world is firmly grasped. The whole of Euro-Asia is the stage of action of the drama.

For the facility of reference, we give the approximately known chronological dates in the form of six tables :

Table	I	:	Geological chronology
,,	II	:	Glacial ages
,,	III	:	Six substages of the fourth glacial age
,,	IV	:	Man in Pleistocene era

" V : Archaeological terms used in human evolution recalled

" VI : a) Chronology of the near East - Mesopotamia.

b) " of Egypt.

c) " of the XVIII the dynasty.

CHRONOLOGICAL BACKGROUND
TABLE I
Geological Chronology

Cenozoic era	Recent-Paleocene	(0-1) million years ago
Mesozoic era	Cretaceous-Triassic	(1-200) million years ago
Paleozoic era	Permian-Cambrian	(200-500) million years ago
Pre-Cambrian era		(500-5,000) million years ago

Cenozoic era (Detailed)

Period	Epoch	Distinctive records of life	Thousand years ago
1	2	3	4
A. Quarternery	Recent	Modern man (homo-sapiens)	(0-44)
	Pleistocene	Early man (hominids)	(44-1,000)
B. Tertiary	Pliocene	Large carnivora	
	Miocene	Whales, Apes, Gazing forms	
	Oligocene	Large browsing animals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	

TABLE II

PLEISTOCENE EPOCH (GLACIAL AGES)

	Standard	American	Years ago	
4th Glacial	Wurm glacial	Wisconsin	(64-11)	thousand
3rd interglacial	Riss-Wurm interglacial	Sangaman inter-glacial	(274-64)	thousand
3rd glacial	Riss glacial	Ithnoisglacial	(330-274)	thousand
2nd interglacial	Mindel-Riss (interglacial)	Yarmouth (inter-glacial	(700-274)	thousand
2nd glacial	Mindel (glacial)	Kansan (glacial)	(?-700)	thousand
Ist interglacial	Gunz-Mindel (interglacial)	Aftonian (inter-glacial)		...
Ist glacial	Gunz glacial	Nebraskian glacial		...

TABLE III

Six substages of 4th (Wurm) glacial age

Loess	Radio Carbon (years ago)	Geological (years ago)	Equilibrium method (years ago)	
			by (Anthenes)	by (Kay)
6. Valders (advance) (b)	11,400	11,000		
5. Mankato	12,000	15,000	12.000	25,000
4. Cary	(14,000-13,000)	26,000		
3. Tazedvell (sediment)	(19,000-15,000)	37,000		
2. Lowan (wood)	(23,000-21,000)	51,000		
1. Framdale (wood)	(25,000-29,000)	64,000		

a) Equilibrium method : "per cent of equilibrium for uranium, ionium & radium"

b) Sweden = 6,839 B. C. : De Geers by 'advance' method (see Wheeler : *New Techniques in Archaeology, p. p.* 389, outline of Modern Knowledge.

c) The radio-carbon method gives low dates (about half of the geological dates) : Therefore, in the meantime, respect is held for carefully documented stratigraphic work and sampling of the geologists.

TABLE IV

MAN IN PLEISTOCENE ERA

LOWER PALEOLITHIC

Culture	Period	Remarks
Somme 1) Abbevillian [Abbevile, France]	Lower Pleistocine — Ist Interglacial	Bifacial or hand axe
Thames 2) Acheulean [St. Acheul, Somme, France]	2nd interglacial — End of third interglacial	Use of wooden or bone billet
3) Clactonian [Clacton, Essex]	Early second interglacial	Flakes
4) Levalloisians [Levallois, near Paris]	Late second interglacial	Flakes

MIDDLE PALAEOLITHIC

Mousterian	Third interglacial — 4th glacial	Flakes : Remains of modern-man found

UPPER PALAEOLITHIC : BEGINNING OF CIVILIZATION

1) Lower perigordian	South Central France	(35,000—28,000) B. C.	
2) Aurignacian	Aurignac (Hante-Garone)	(28,000—23,000) B. C.	Art begins
3) Upper Perigordian	.. ..	(23,000—18,000) B. C.	Art persists
4) Solutrean	Solutre (France)	(18,000—14,000) B. C.	Art develops
5) Magdalenian	La Madeleine	(14,000 — 8,000) B. C.	Finest specimens of cave art.

TABLE V

For the appreciation of the nonarchaeologists a tentative description for the evolutionary classification is given :—

A. Ist stage of archaeology

1) Stone Age
2) Bronze Age
3) Copper Age
4) Iron Age

B. 2nd stage of archaeology (classification by tools & implements : 'Liths' means stone)

			Years ago		
A	1)	Palaeolithic	4,00,000	—	25,000
	2)	Mesolithic	25,000	—	8,000
	3)	Neolithic	8,000	—	5,000
	4)	Chalcolithic	5,000	—	4,000
	5)	Copper age	4,000	—	3,500
	6)	Iron age	3,500		

Prefixes mega- and micro- are associated with the size of the tools. Microliths denoted fine workmanship and advanced stage of the stone age.

A classification favoured by the social scientist is :—

B 1. Hunting-foodgleaniag stage
2. Pastoral stage
3. Food producing stage
4. Agricultural stage
5. Manufacture of bronze, and trading stage
6. Iron stage

A new classification by habitat

We propose another evolutionary classification for true men (*homo sapiens*) based on habitat :

C.		Years ago
1.	Cave dwelling stage	35,000
2.	Man made habitat stage	
	(Semi-cave, nest-type huts, etc.)	15,000
3.	Huts-hamlets stage	7,000
4.	Village stage	6,000
5.	Town and township stage	5,000
6.	City stage	4,500

Each sub-division in the above classification i. e. (A) Tools (B) Food raising and (C) Habitat, has some chronological significance because one stage of culture follows another: One stage usually evolving from the other. However, it is rash to make an attempt at absolute chronology on their basis alone.

Firstly, many cultures can grow, live and remain, side by side. Even today [1970 A. D.], for instance, we can find stone tools [Pestles and mortars, grinding stone etc. in use, even in Delhi, and particularly, in surrounding villages].

Secondly, the same culture (e. g. village habitat) may have appeared at very different epochs in different countries. Our chronology (wherever given above) follows Al Ubaid and Halaf.

Thirdly and finally, the stage of material culture has no correspondence to the mental [and, in particular, to to the spiritual] development — which is the main subject of the present enquiry. In traditional India, the best minds live in caves and huts. Munis (cave dwellers) have produced the *Sankhya* and the *Yoga* while Rishis (hut dwellers) have produced the *upanishads* - the

highest level reached by man's spiritual intuition. To quote the latest outstanding example, Gandhi, the great soul, lived in a mud hut at Savarmati.

Our main problem is to find a chronological evolution of the mind, and it would be incorrect to assume (at the outset) that it is linked with material progress.

In fact, the material collected would tend to show that *the evolution of human spirit and intuition has its own chronological laws : It is even possible that spiritually, men degenerate with material affluenee (if the affluence goes beyond a certain limit).*

TABLE VI

a) Mesopotamia

	North	**South**
5000 B. C.	JARMO HASSUNAH HALAF NORTH UBAID GAWRA	 ERIDU, WARKA SOUTH UBAID PROTO-LITERATE
3000 B. C.	NINEVITE North AKKADIAN	EARLY DYNASTIC, PROTO IMPERIAL & AKKADIAN
2000 B. C.	Post AKKADIAN, OLD ASSYRIAN, MIDDLE ASSYRIAN	GUTIUM & UR III, ISIN-LARSA, OLD BABYLONIAN
1700 B. C.		KASSITE

TABLE VI

b) Egypt

(3,200 —	2,680)	B. C.	ARCHAIC	Ist to 3rd Dynasties
(2,680 —	2,258)	B. C.	PYRAMID or OLD KINGDOM	4th to 6th Dynasties
(2,258 —	2,052)	B, C.	First Inter-mediate period	9th, 10th & part of 11th Dynasties.
(2,052 —	1,786)	B. C.	Middle Kingdom	11th & 12th Dynasties
(1,786 —	1,570)	B. C.	Second Intermediate	13th to 17th Dynasties
(1,570 —	1,085)	B. C.	NEW Empire	18th to 20th Dynasties
(1,085 —	332)	B. C.		21st to 31st Dynasties, Alexandar's conquest

TABLE VI

(c) The XVIIIth and XIXth Dynasty of Egypt

Name of the Pharaoh	Arthur Weigall	Sir Alan Gardiner	James Henry Breasted
Ahmose	1576-51	1575-1550	1580-1557
Thoserkere Amenhotpe	1551-26	1550-1528	1557-1501
Thutmose I	1526-13	1528-1510	
Thutmose II	1513-1493	1510-1490	1501-1447 (including Thutmose II and Hetsheput)
Hetsheput (daughter of Thotmose I) jointly with Thutmose III (stepson of Hetsheput)	1,493-1,480	1,490-1,468	
Thutmose III	1,493-1,440	1,490-1,436	
Oekher-perure or Amenhotpe II	1.440-1,415	1,436-1,413	1,448-1,420
Menkkhe-perure or Thtumose IV	1,415-1,406	1,413-1,405	1,420-1,411

Amenhotpel III	1,406-1,370	1,405-1,367	1,411-1,375
Neferkheperure or Amenhotpe IV or Akhnaton	1,370-1,354	1,367-1,350	1,375-1,350
Tutenkaton or Tutenkhamen	1,354-1,345	1,347-1,339	
Ay (father in law of Akhnaton)	1,345-1,341	1,339-1,335	
Horemhab	1,341-1,317	1,335-1,308	

End of Eighteenth Dynasty. All dates are B. C.

TABLE VI

(d) NINETEENTH DYNASTY

Rameses I or Menpehitre Remoses	1,317-1,316	1,308-1,291	1,315-1,314
Menmaere Seti	1,316-1,295	1,309-1,291	1,313-1,292
Rameses II or Usermaere	1,295-1,225	1,290-1,224	1,295-1,225
Menmaere Amenmosis	1,220-1,219		1,215-

Siptah (i.e. Akhnere Merenptah Siptah)	1,219-1,213	1,208-1,202	1,215-1,209
Userkhe-perure Merenptah Siptah	1,213-1,209	1,208-1,202	1,209-1,205
Tivare (Sitremerya mun Twosre-setep tenmut)	1,209-1,205	1,202-1,194	1,205-1,200

(Personal communication : K. C. Varma)

TABLE VI

(e) TABLE OF CHINESE DYNASTIES

NAME	DATES	CENTURIES (*approximate*)	REMARKS
(Mythical)	2697-2206 B. C.	XXVII-XXIII	Legendary
Hsia	2205-1784 B. C.	XXII-XIX	Together with Chou, called "Santai" or "Three Dynasties."
Shan (Yin)	1783-1123 B. C.	XVIII-XII	
Chou	1122-222 B. C.	XI-III	Classic period Ch'unch'iu period 722-431, Chankuo period 403-221.

Ch'in	221-207 B. C.	end of III	Re-unified China,
Han	206 B. C. A. D. 209	II B. C.-A. D. II	"Eastern Han" from A. D. 25.
Wei	220-264	middle III	Wei Wu and Shu forming the "Three Kingdoms" from about A. D. 200.
Chin	265-419	mid. III-IV	"Eastern Chin" from 317. Barbarians' kingdoms in North China 304-439.
"North and South"			
Sung	420-478	V-VI	There are called "North and South" Dynasties for distinction. Together with preceding Wu and Eastern Chin, called "Six Dynasties', a term referring to southern culture.
Ch'i	479-501		
Liang	502-556		
Ch'en	557-588		

IX

Birth of Sciences and Technology :

Introduction

What are the distinct attributes of civilization at the primitive stage of evolution of human culture i. e. what are the insignia which differentiate a man from an animal ?

Use of speech, tools and fire, in our opinion, are the three major elements which distinguish a man from a beast. Speech is an instance of 'pure thought' while the primitive use of tools and fire are examples of applied thought i. e. technology in its infancy. Another evidence of human awakening is the picture and the painting, which the primitive savage left behind : the earliest paintings known to man were drawn in the caves of France (Lasceaux) and Spain (Altermira), some 20,000 years ago.

What is meant by science ? In the context of our study, (viz., in the context of the birth of human civilization) science could be defined as man's first understanding of the processes of nature around him. Fore-knowledge — some kind of prediction — is the distinguishing essence a science *vis a vis* other kinds of knowledge, and science was born when man not only caught some order in natural phenomena but also made some dim predictions about them.

Apparently, the first step in science was an acquaintance with the seasons and its regularity. Very early in his evolution,

man acquired a dim knowledge of the regularity in seasons — how summer, rains, autumn, winter, spring (the sweet season of mating), and, *then again summer,* followed one another in a regular invariable rhythm. This was not a mere idle curiosity because it was vital and crucial in the primitive man's life — whether he was a fruit-gatherer or a hunter on the lookout for beasts of prey. A 'fore-knowledge' of the onset of a season became an unavoidable necessity, when men began to produce food i. e. when he began his rudimentary agriculture.

At this stage, we shall not give our proposed chronology of the various important events in the world of science because that is the very problem we have to solve, if at all possible. However, to make one's ideas clear and concrete about the vast canvas of time involved, we give the upper limits which have been suggested by such distinguished authorities as Harrison, Okley, etc.

Fire used 4,00,000 years ago (Palaeolithic)

Tools used 4,00,000 years ago (Palaeolithic)

Fire produced 1,50,000 years ago (Palaeolithic)

Speech — rudimentary — 1,00,000 years ago (Neanderthal)

Sommerfield is more conservative and thinks that the progress evolution in old palaeolithic stage was very slow.

Marshack has shown that Aurignacean cave man observed moon in its bimonthly cycle of 59 days and recorded them by dots and notches on his antlers some 25,000 years ago.

A probable (though conservative) time span where the chronology is set, might be the following :

Event	*Years ago*
Use of fire	4,00,000
Rudimentary speech sounds (identifying words, curt orders, interjections etc.- almost grunts).	1,00,000 (Neanderthal)

Counting and recording	25,000 (Lower Perigordean : Aurignacean)
Paintings (Altemira Caves Lasceaux Caves etc.)	15,000—10,000
Village culture	7,000 (Al Ubaid and Halaf)
Fire-burnt bricks and wheel turned pottery	6,000 (Al Ubaid and Halaf)
Writing and marks	5,500

It seems that we can use a logarithmic scale to define the velocity of evolution of civilization.

Going backwards : Log T = C.

This means that relatively equal amounts of progress were made in 10,00,000 years, 1,00,000 years, 10,000 years, 1000 years, 100 years, 10 years : *Our civilization is, therefore, explosive.*

We have to answer the following :

	Years ago
Use of regular speech : (identification words and action words in coherent speech)	??
Control of fire	??
Identification and naming of bright stars	??
Knowledge of regularities of seasons	??
Foreknowledge of seasons	??
Domestication of cattle (in particular horse and oxen)	??

Evolution of cultures :

Fire

There are definite remains of the use of fire by Peking hominids. This can be certainly dated to 3,00.000 years ago, if not earlier. Some authorities would be prepared to push it back to 4,00,000 years ago.

The hominids who used fire were men-like; not true men (homo sapiens) yet the hominids were ancestors of men. Hominids were already differentiated from the apes : apes grew from another line. The Peking men have been called Pithecanthropus (pithecus — apes; anthropos — men) or apemen : However, we need not take this classification absolutely but would merely call them hominids or men-like creatures :

Heidelberg men as well as Neanderthal men (we would like to call them also hominids), used fire at least 1,00,000 years ago, if not earlier.

They *used* fire but it is not known whether they could 'strike a fire' or 'light a fire' at will. We may safely ascribe the striking of the fire at will, to modern men (homo sapiens) who suddenly appeared on the European scene, some (35,000—40,000) years ago. They have been described as Cro-magnon people and perhaps came from the East. Four cultures arising with them — Perigordian, Aurignacean, Solutrean and Magdalanean are known and well established. We consider that Magdelaneans c. (15,000—8000 years ago) had fully controlled fire : they could light *flames* at will. This must be so, because the finest cave paintings are found deep inside the caves which are dark otherwise.

The Magdelaneans must have known the percussion method of producing fire. We also presume (though no proof is available) that they knew the friction method (whirling a stick in a hole — the Aryan *arani manthana* method.)

To sum up :

1) Fire was preserved and used......3,00,000 years ago [Peking man]

2) Control of fire [Cro-magnon man] 35,000 years ago

Tools

Stone tools, (i. e. hand axes) are found with Peking men at least 3,00,000 years ago, if not earlier. The whole of prehistoric archaeology is an attempt to discover, unearth and describe these stone artefacts. We, therefore, need not give further details.

However, a word about the 'burins' of the Cromagnon people is called for. With these burins, finer and yet finer tools were made : Needles (with eye) were made — and skins were sewn. This occured some 30,000 years ago.

Arts

Cromagnon people were familiar with arts — rudimentary paintings appear 30,000 years ago : We also get models (crude no doubt — but yet works of art) 20,000 years ago.

The Spanish and French caves of 15,000 years ago, show paintings in single and multiple colours in full grandeur. Arts, therefore, blossomed fully, some 15,000 years ago.

Bow-arrow

The arrow-heads [in flake] appear 15,000 years ago : The Cromagnon people knew about bow and arrow 15,000 years ago.

Speech

Archaeology cannot disclose anything about human speech because no trace of human speech is left behind. We have necessarily to go by conjectures.

Traces of human writing are found in Sumeria in *c.* 3,500 B. C. In other words, human speech was developed so far as to require writing 5,500 years ago.

At the other end of the time-scale, the anatomists say that the speech centre of the Neanderthal skull is found to be so developed, that they could utter some rudimentary speech. This means that human speech was born say, 100,000 years ago.

Next in the scale of development, we find that men lived a group life 30,000 years ago. They hunted together, because in the earliest cave paintings we find scenes of group huntings. Hunting together necessitated organized activity — which was not possible without close coordination; some form of speech was absolutely necessary. It is safe to presume that organised coherent speech existed — 30,000 years ago. (Aurignacian - lower Perigordian people).

Next we come to cave paintings. Fully developed huge cave paintings of 15,000 years ago, have been found. There are three theories regarding them.

1) They merely show expression of artistic impulse : Art for for art's sake.

2) They were some form of magic,

3) The latest theory is that they represent some form of elaborate rituals — which were enacted before them.

Whatever may be their *raison d'etre,* the fact that fully developed speech was at their back can be accepted. In particular, if these paintings — deep inside a cave and inaccessible otherwise — represented some form of elaborate rituals, then they also coexisted with some esoteric speech.

The modern trend is also to associate them with unconscious symbolism. (e. g. that bisons represents females ; orochs represent male, etc.) :

This esoteric ritualism theory finds a distant echo in a *mantra (hymn)* of the Rigveda.

"Catvari vak, parimita padani
Tani vidur brahmana ye manishinah
GUHA Trini nihita, na ingayanti,
Turiyam vaco, manushya vadanti". R. V. 1/164/45

"Four are the grades *(parimita)* of speech. The Brahmans who are wise, know them. They are deposited in secret caves and no one knows their meanings. The fourth (grade) is spoken by men".

Usually the interpretation of this hymn is *esoteric* and mystic. A perfectly simple meaning, could be given with reference to these caves — where esoteric paintings occur in the innermost recesses viz :— "The paintings are symbolic and contain some esoteric meanings. These meanings were known to the initiate who conducted the rites and rituals (i. e. the Brahmans). The ordinary speech of men is the fourth".

In other words, (1) GUHA literally means a cave : And these paintings do have some symbolic value.

(2) Brahmans were shamans who conducted these rituals and who knew the significance of the picture-symbolism.

Development of speech

Original speech could hardly be more than grunts and "sh ...." sounds indicating silence : The call-sounds [Ho, Ha He ...... etc.] also must have been some of the first to come out.

The next group of sounds could be curt orders [e. g., Run ! flee ! come !], or, those indicating names i. e. identifying words. Panini called them *tim* (verbs) and *sup* (nominals) respectively.

Very early, they must have also distinguished different things and objects e. g. a bison, a horse, an ororochs, a deer, by whatever name called.

We now make the hypothesis viz., that originally (c. 20,000 B. P) human speech was one; only this hypothesis accounts for the identity of root words. The original speech is usually called Indo-European.

It follows that these original Cro-magnards [with their four cultures viz. Perigordean, Aurignacean, Soultrean and Magdalenean] were precursors of people who later (after thousands of years) composed the vedic hymns. In other words, we may postulate that these Cro-magnards spoke a language which is the mother of most languages of the Indian and European family. We shall call it — Indo-European (say, speech X).

We shall now try to trace some roots:

Root	**VEDIC**	**INDO-EUROPEAN**
Pa	PITR'	Father
Ma	MATR'	Mother
Bhr	BHRATR'	Brother
SWAS	SWASR'	Sister
PAD	PADA	PIED, Foot
MA	MANA	MEN (measure)
NAKH	NAKT	NACHT (Night)
DIV	DEVA	DIEU
	DIVA	Day
VAK	VAC	Voc (vocal)
LOK	LOK	LOGOS
		Look
RIT	RITAM	RIGHT, RECHT
	RITU	RHYTHM
EJ	EJATI	Agitate
IL'	IL'E	Adore

O(R)X	UKSHA	OX
SON	SUNU	SON
IGN	IGNI	IGNIS
HR'T	HRIDAYA	HEART
SAKH	SAKHI'	Psyche, Sakee
JUS	JUS	JUICE
MR'T	MR'TYU	MORT
STR"	1) STR"	STAR
	2) STRI	ISHTAR

Root	**Skt**	**European**
BON	VON	BON, BENE, Venus
VARUNA	VARUNA	URANUS
DYAUS	DYAU	ZEUS
MAN	1) MANUSHYA	MAN
	2) MANAS	MIND
	3) MA (measure)	MENS
UN	?	UNE
DWI	DWI	TWO
TRI	TRI	THREE
PANC	PANCA	PENT
SASH	SHASHTHA	SIX
SAPTA	SAPTA	SEPTA
ASTA	ASTA	HECTA
NAVA	NAVA	NINE, NON
SHATA	SHATA	CENTUM
ASV	ASVA	ASVO (=ASS)
MITH	MITHYA	MYTH
MAYA	MAYI	MAGI, MAGIC
(Polish)		
SWIATEO	SVETA	LIGHT
SWIAT		WORLD

SWIETNOSE	GLORY, MAGNIFICENCE
SWIT	THE BREAK OF THE DAY
SWIECIC	TO PRODUCE LIGHT

To sum up :	**Years ago**
1) Use of regular speech	30,000
2) Observations on moon and records	25,000
3) Control of fire	30,000

Thus, the birth of sciences and civilizations is due perhaps to the Cromagnon people — some 30,000 years ago.

Were they the people whose lore is carried in the Rigveda ? Who knows ?

X

Archaeo-astronomy and Ethno-astronomy

In her well documented article in the *Current Anthropology*, October 1973, Baity has given a comprehensive account of the recent work (1950-1972), on the two new sciences of archaeo-astronomy and ethno-astronomy. As this article is likely to be used as a basic index of reference because of its comprehensive coverage, the author could have also given a brief digest of the earlier work on the subject. This we do now, particularly for the work done in India in respect of the ethno-astronomy viz. on the astronomical interpretation of the traditions of the Indo-Europeans available in ancient texts.

The great Indologist Sir William Jones,[1] suggested that the precession of equinoxes could be used to define the chronology of the Indo-European pre-history reflected in the Vedic works. Colebrooke[2] did the pioneering work of identifying the Nakshatras. Jacobi in an important article on "The date of the Rigveda"[3] showed that the traditions of year-beginnings contained in the Rigveda go back to *circa* 4,400 B. C. Independently, Tilak in his 'Orion'[4] reached the same conclusion. Buhler supported these pioneering attempts.

The source book for these scholars were the Vedic texts. Of them, the Rig Veda is an unique text for the ethnologist: It is a collection of hymns (sacradotal, mystic and astronomical), and a *complete*

See Dr. E. Baity, Archaeoastronomy and ethnoastronomy so far, *Current Anthropology*, Oct. 1973, pp.389 at 436

index thereof was made in *circa* 1300 B. C. by the scholiasts Shaunaka and Katyayana. Since then i.e., since 1,300 B. C., it has been preserved intact by a complex scheme of variant recitations; and, therefore, not even half a syllable could be changed in these sacred texts. It is, therefore, an unique and indispensable source of perfectly maintained traditions (traditions which already assumed hoary antiquity in 1,300 B. C. !) for the student of Indo-European prehistory. An example will suffice :

Baity has (conclusively) established that the "stage's horn" was extensively used in astro-religious symbolism to denote equinoxes. What then is the 'stag's head'?

In Vedic astronomy, a bright star was used to mark the equinox: It was called Mriga-shiras which means literally 'Stag's head' (mriga-Stag; shiras=head). Mriga-shiras is the bright star λ Orionis (Long-84°) The full moon at the stag's head (λ Orionis) marked the autumnal equinox in *circa* 4,100 B. C. The establishment of this tradition, incidentally, is the central theme of Tilak's *Orion*, to which a reference has already been made.

What is of crucial importance in applying astronomical method to the chronology of periods prior to 6,000 B. C., however, is to note that the worker should keep the quarter-phase shift (after every 6,500 years) carefully in view. For instance, for the full moons at the star λ Orionis (Stag's head) itself, we have,

Full moon at Orionis marks :	Circa	Culture
Autumn equinox	4,100 B. C.	Neolithic
Summer solstice	10,600 B. C.	Magdalanean
Spring equinox	17,100 B. C.	Solutrean
Winter solstice	23,600 B. C.	Aurignacean
Autumn equinox	30,100 B. C.	Lower Perigordean

Similarly, if the observation was of new moon (or, what is the same thing, of heliacal rising of a bright star), there is a half-phase

shift. For instance, for the important Indo-European god-hero ASWAYUJAU (—harnesser of ass-like horses : see cave paintings at Altemira, Lasceaux, etc.) represented by the star β Arietis, we have,

Heliacal rising at β Arieties marks	*circa*	Period
Spring equinox	500 B. C.	Historic
Winter solstice	7,000 B. C.	End of Valders (Winconsim) sub-phase
Autumnal equinox	13,500 B. C.	Magdelanean
Summer solstice	20,000 B. C.	upper Perigordean
Spring equinox	26,500 B. C.	Aurignacean

Imagination should not be allowed to boggle, while considering these vast distances in time, but the worker should carefully analyse the phenomenon observed, the geographical locale, and above all, the *culture to which it is related*, before drawing any chronological inference.

The moon as the time-measurer

The primitive man of the pleistocene age used the Moon (and not the Sun) as the time-measurer. Marshack* has shown that the Aurignacean knew that the moon completes two full moons in 59 days (in sets of 30+29, or more probably, 15, 15, 14, 15).

The ancient (pre-vedic) Indo-Europeans also used a season of two months, and called it a RITU. The word 'moon' and 'ritu' are Indo-European words of key significance as has already been shown. Yaska writing in *c. 1400,* says in his lexicon — the Nirukta [5. 4.],

* See p. 102

that moon was the *masakrit,* the maker of the months : He measured the month while traversing the nakshatras — the belt of 27 stars.

(see *p.p.* 8-13, *supra* for details)

Moon astronomy and calendar marking

Baity has laid too much emphasis on the Sun-calendar, and we feel that the importance of the 'moon-astronomy' has not been sufficiently stressed. An ethnologist cannot forget that the moon was the first time-measurer of the primitive man. If he forgets, then Marshack will remind him that the Aurignacean knew (perhaps 20,000 years ago) that the moon completes a season (RITU) of two full moons in FIFTYNINE DAYS and recorded them in his antler batons :

The primary observation of the Pleistocene man must have been crude, and, therefore, simple. He (or rather, she — as has been already shown) observed only the Nakshatra at which the moon was full when a season was beginning, ('Nakshatra' is a vedic word for a bright star used to define the position of the moon in the celestial circle in which the moon moves round the month; there were naturally twenty-seven of them, now identified by Colebrooke). The primary rituals were the PURNIMA or (or rather, PURNAMASA or full-month) rituals. Autumn was the first season and the autumnal equinox was marked by the 'autumn star'. A "hundred autumns" meant a hundred years. The calendar was, therefore, as simple as the Pleistocene cave man could easily follow.

The Indo-European also used a simple system of calendar based on the step-wise motion of the full moon in the Nakshatra circle. The Rigvedic lore prescribes elaborate full-moon and new-moon rituals (DARSHA and PURNAMASA rituals) *to be observed at particular nakshatras*. The observation of the bright star at which the full moon (or the new moon) occured was a distinguishing

hallmark of the vedic (and the prevedic) Indo-European calendar making.

For instance, after Punarvasu (— Pollux) was declared to be the autumn star by Aditi, the autumn rituals, sacrifices and festivals were observed when *(and only when)* the moon was full at Pollux. The injunction of Aditi, the mother of the system, was "Observe the autumn festival when (and only when) the moon is full at my star".

Being star-bound i.e. being siderial, the system is admirably suited for chronological computations. For, it is hardly necessary to point out that when the moon is full at say, Rohni (—Aldebaran - Long. 69°), the Sun will be at 249° (69°+180°) : and, beit noted that the 'opposite' star at the longitude 249° was called JYESHTHA ROHINI or *elder* Rohini, showing clearly that the Vedic astronomers had a clear notion of the celestial circle even in *circa* 3,100 B. C. : for, one rises when the other sets. The epoch was *circa* 3,100 B. C., when the autumnal equinox was taking place at the Rohini full moon.

Incidentally, the control and linking of the full moon with the star at which it occurs, automatically calls for the inclusion of an extra full-moon in the third year (observational intercalation). Thus, thirty seven full moons were needed to complete a cycle called *yuga*. It meant that a year was made up of 370 moon-days (called *tithis* in the Vedas) An extra month was needed after thirty years for finer correction. Viswamitra, a brilliant astronomer-poet of the Rigveda observed that a similar result was achieved by a secondary intercalation after the ninth year. The method was so accurate that he could determine that a period of nine years contained 3,339 moon-days (— *dyus* or *tithis,* vide the hymn Rigveda 3.9.9). This means that a Viswamitra year was made up of 371 *tithis* which is equivalent to a period of 365.20 days. Viswamitra lived in *circa* 2500 B. C., and therefore, his determination was an achievement of the very first magnitude by any standard.

All this was achieved by naked eye observation of the moon without any clock other than the clock of the seasons (and of course, the menstrual clock), and, therefore, the importance of the moon astronomy should not be minimised, particularly for the periods prior to 2,000 B. C.[6]

To sum up :

1. Baity has well made out the case for an intensive study of astronomy by the ethnologist and the archaeologist. There is a grand cosmic clock in the high heavens whose invisible hands turn once in 26,000 years. Those who can read it, can read the past with unerring accuracy : For, the Sun and the Moon will bear witness to what they will say in the court of the stars : CANDRA-ARKAU YATRA SAKSHINAU, NAKSHATRA SABHAYAM.

2. A serious study of the astronomical legends of the Rigveda containing the prehistoric traditions of the Indo-Europeans would be a fruitful source of exploration for the ethno-astronomers.

3. More attention should be given to the simple (and crude) moon-observations used by the pre-vedic Indo-Europeans rather than the more accurate (and, therefore, more sophisticated) observations needed for a solar calendar and planetary astronomy.

4. It would be necessary to go beyond the first quarter-phase of the precession cycle of 26,000 years, while studying astronomically the astro-religious symbolisms of the Magdelanean (8,000-14,000) B. C., the Solutreans (14,000-18.000) B. C., the upper Perigordeans (18,000-23,000) B. C. and the Aurignaceans (23,000-28,000) B. C.

5. A comprehensive but simple text on the 'moon astronomy' (as simple as could be understood and *used* by say, a Magdeleanean cave-dweller of 12,000 B. C.) is a *desideratum**. This would be understood and used by an archaeologist (not with an electronic

* The present monograph is indeed written to meet this longfelt want.

computer but — as suggested by Marshack — with simple dots and notches marked on an antler :) An ethnologist must learn to look at the stars and know how to locate the East direction : For, one cannot hope to understand and interpret the spirit of an Aurignacean unless one can mentally go back to his epoch and rejoice when the Sun turns north.

Foot-notes

1. Sir William Jones, *Journal of the Asiatic Society*, 2.

2. Colebrooke H. W., *Collected works*.

3. Jacobi, On the date of the Rig-veda, *Indian Antiquary* 23:154-59.

4. Tilak, B. G., *1894*, *Orion*. Poona.

5. Buhler G., On the date of the Rig Veda. *Indian Antiquary* 23:238-49.

6. Roy S. B., Chronological Infrastructure of Indian Protohistory in the Journal of the Bihar Research Society, 1972 pp. 44-72.

XI

The Mother - Goddess of the Laussal Caves

- a chronological study in archaeo-astronomy

Summary

1. The horn-like object in the hand of the Mother-Goddess at the Laussel cave is identified as the last visible phase of the moon. Lunar cusp is symbolised by the *cornucopia* of the Aurignacean.

2. It is found that the Aurignacean-upper Perigordian people could observe the phases of the moon, and record them in an intelligent context — thus supporting Marshack's thesis (1) to the same effect.

3. If the mother goddess is connected with the star Pollux as suggested by the ancient traditions contained in the Rigveda — traditions which had acquired hoary antiquity even in the Veda itself — then, the probable date of the statue can be computed, because the depiction will be read as symbol lically showing the new year festival at the autumnal equinox.

4. The date is found to be :
Upper limit...........21,000 B. C
Lower limit...........19,000 B. C.

According to the archaeologists (Bruhl-(*Four Hundred Centuries Of Cave Art*) the date is estimated at 20,000 B.C. (the lowest limit is said to be *c*. 15,000 B. C.)

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(1) Marschack, A, 1964. Lunar notation on upper Palaeolithic remains, *Science* 146 : 743-45.
1972 a. Cognitive aspect of the upper Palaeolithic engraving, Current Anthropology 13 : 445-61.
1972 b. The Roots of Civilization : Macgraw Hill.

5. On the other hand, if the date is taken to be given, then the study would show that a complex astro-religous magical *cum* social interpretation of the Palaeolithic cave art is not only permissible but plausible.

Introduction

One of the most interesting human statues known, is the figure of the mother goddess found at the entrance to the caves at Laussel. It has been extensively photographed, and the present study is based on the text and illustrations of Abbe H Breuil : Four hundred Centuries of Cave Art.

The statue is 47 cm. high and depicts a female marked by steatopygy (excessive fat). It is an evident depiction of the matriarch — who is probably being deified. It is the earliest known human figure, and the Cambridge History, reads :

"PALAEOLITHIC ART

....

'(c)' The Venus of Laussel, Dordogne, carved on a block of limestone which originally formed part of the entrance to the cave, in false relief produced by cutting away the background around the outline only. As usual, the face has no details, but the rest of the body is carefully studied. The woman holds a bison's horn in her right hand, perhaps the '*cornucopia* of the Aurignacean' (Sellas : The Laussel cave deposit is of the upper Aurignacean age'.").

In this study,an attempt is made to determine its date astronomically.

The cornucopia of the Aurignacean

The object held in the hand of the mother goddess is usually held to be a horn — the symbol of fruitfulness and plently. What

is the origin of this symbolism ? What does the 'horn' symbolise and signify ?

It is particularly important to notice the significance of the marks on the horn. A careful count shows that there are thirteen notches marked thereon. This proves conclusively (whatever else the significance may be) that :

a) The Aurignacean could count,
b) Could count up to thirteen, and,
c) Could record the observations permanently in an intelligent context.

This fully supports the findings of Marshack that (a) the Aurignacean could count, (b) could observe tbe phases of the moon, and (c) record their observations on antlers in sub-groups of 59

What is the interpretation or significance of the number thirteen recorded on the object held by the mother goddess ? Before answering this question some ancillary topics will have to be discussed.

Significance of the cave art

Three kinds of theories have been advanced so far, for explaining the significance of the figures drawn in the Palaeolithic caves :

1. That they are pure objects of art — art for art's sake (Pure imitative art)
2. That they represent some magic — magic perhaps for fertility, perhaps for plenty, or, perhaps for hunting. (Reinach, Breuil, Begouen)
3. That they express some deep-seated urge of the sub-conscious — perhaps in a Freudian pattern of sex. (Leroi Gourhan).

The author subscribes to the second view viz., that they represent some esoteric cult object. It is quite probable that there is no single *motif* : that all the three urges inspired the palaeolithic artist to his paintings, engravings and sculptures. However, it will be shown that the esoteric cult aspect becomes predominant in some characteristically important pieces, e. g., in the Mother Goddess, or in the Sorcerer of the Sanctuary of the caves of the Les Trois Frere.

The second view propounded by Reinach, Breuil and others, gain support from a very ancient tradition (perhaps coming down from the very dawn of history) retained in the Rigvedic hymn I-164-45 composed in c. 2,300 B. C. It says, *inter alia :*

R. V. I-164-45

'Four are the grades of speech (*Vak, secret words of power*, *or the Logos) :* Those Brahmans (i. e. magis or the knowers of the secrets *of the heaven and the earth*) who are wise, know them. *These are deposited in the secret caves :* They indicate no meanings (i. e. *their secrets are sealed in the caves :* Men *i.e. ordinary men who do not know them)* only know and speak the fourth grade.

(The translation is literal — the comments in brackets are supplied by the author).

This hymn clearly talks of a secret wisdom deposited in dark caves and known only to the initiate. Breuil's vivid graphic description of the difficult and hazardous passage to the 'sanctuary' which is located in the innermost part of the Les Trois Frere caves, is lucidly explained by the above passage of the Rigveda: The access to the God — the Sorcerer with the Antler's head — ought to be as difficult as possible, so that his secrets are closely guarded among the initiates only.

Proper time for the rituals

There is another important aspect. Whatever be the nature

of the ritual — magical, mystical or symbolic — it had to necessarily performed at a particular auspicious moment. Unless the timing was perfect, the magic would lose all its potency and efficacy : And, therefore, its performence was strictly controlled and timed.

The 'timing' of a rite has great chronological significance as we shall presently show. For, the proper timing was effected by the position of the moon (in particular, of the full moon or the new moon) among the stars at a particular season. The ancient wise men looked up at the heavens to ascertain the proper timing, because the Moon was the most ancient time keeper says Yaska, the ancient lexicographer in his Nighantu and Nirukta (5.4), (the key to the difficult words of the Rigveda (*c*. 1,400 B. C.) see p. 3, *supra*.

Hence its importance in chronology. If the position of the sun and the full/new moon among the stars is known *at the season of these observances and rituals,* then its absolute date can be computed. The priest determines the auspicious moment by the sun, the moon, the stars, and, in particular the season : *And they are also sufficient to determine the absolute date and epoch of that auspicious moment.*

This is possible because the seasons slowly advance — completing one revolution in about 26,000 years, owing to the precession of the equinoxes. Those who can read this celestial chronometer of precession, can read the date of any past event : The sun and the moon will bear witness to what they would say.

The moon and the mother goddess

It is suggested that the horn-like object in the right hand of the mother goddess be identified as the last phase of the crescent moon. The figure would then mean that the mother goddess is holding the crescent moon in her right hand.

The horn actually represents the cusp or the last phase of the vanishing moon. In Vedic and the post-vedic

literature, which carries the memory of the hoary forgotten tradition, the cusp and the half-crescent of moon is the emblem of the mother goddess : In *Candi* (*Kilaka-stava*—1.1), the Bible of the Mother-worshippers of India, it is said :

"*NAMAH SOMARDHA-DHARINE*' — we bow to the Mother who holdeth the half moon."

It is strange, how the figure of the mother goddess depicted in the French caves in 20,000 B. C., finds its reflection in an Indian Sanskrit text. Evidently, Jung's theory of the racial or the collective unconscious is more deep-seated, than the individual sexual urge of the Freudian unconscious. God-feeling—urge for a divine protection — is apparently as old as the human mind itself.

In classical Indian astronomy, THE LAST PHASE OF THE VANISHING MOON IS ACTUALLY CALLED THE SHRINGA (=the horn e. g. in Suryasiddhanta).

The cornucopia (the horn of plenty) of the Aurignacean, therefore, is related to the vanishing moon. The exact connection — the precise nature of the symbolism — would become clearer as the study goes on.

The mother goddess is known by different names in different countries. Aditi in the most ancient stratum of the Rigveda; Ishtar, Ashtarte, in Semetic languages; Cybele, Nana and Anahita in West Asia; Venus in Rome. She is Marie in Spain, where she is associated with these errie caves still haunted by the ancient spirits. She becomes the mother Mary, of the Christians.

The Semetic group of words Ishtar, Ashtar, Ashtarte, originate from the root STR. This root '*str*' connotes both a female (skt. *stri*), as well as a star. Thus, the primary mother goddess was the female of the stars, and obviously she had a deep connection with the stars. Perhaps she was their queen — the queen of the stars residing in the high heavens. In the Rigveda, the primary mother goddess Aditi is associated, in particular, with the star Punarvasu[1]

(1) Vasu — Plenty; luminous etc.

Pollux (Long. 1140) [Tait Samhita 4.4.10 observation *circa* 2300 B. C.].

Finally, the mother goddess is associated with the moon in almost every race and culture. Her emblem is generally the crescenf or half-crescent moon. See for instance the iconography of the ancient figures of Isis, Ashtarte or Nana. Incidentally, Nana means naked. Nana is, therefore, the primal mother-goddess naked: The Laussel figure would seem to represent her perfectly.

Thirteen marks on the lunar crescent

We now come to the significance of the number thirteen shown by notches marked on the object held by the mother goddess.

Two interpretations are possible. Firstly, it could represent thirteen months including the thirteenth, or the intercalary month.

The second and the more plausible interpretation would be that they *represent thirteen phases of the moon,* and therefore, the hornlike object represents the moon on the end of the thirteenth night as a thin crescent. The object shows the last visibility of the moon rising as a thin crescent in the Eastern horizon, towards the dawn. Incidentally, this mode of observation later developed into the observation on the heliacal rising of the stars by the Semetics, and the observations on the new moon (*darsha*) of the vedic Aryans.

Chronology and ancient astronomy

We have already explained that the concept of the Mother Goddess originated with the deification of the female Matriarch, who observed the stepwise motion of the new-moon/full-moon among the stars, and gave the injunction that the new year festivals and rituals should begin at her star, the Pollux.

In the Rigveda, the tradition says that Aditi was the mother of the gods—and her star was Punarvasu (*vide supra*).

Now, the star Pollux begins the seasons (and, therefore, the year) as follows :

New moon at Pollux (— long. 113°)

Epoch	Event
31,100 B. C.	Spring equinox
25,600 B. C.	Summer solstice
19,100 B. C.	Autumnal equinox
12,600 B. C.	Winter solstice
6,100 B. C.	Spring equinox

The period relevant for our purpose are as follows :

Culture	Circa
Aurignacean	28,000—23,000 B. C.
Upper Perigordean	23,000—18,000 B. C.

The Laussel figure is probably connected with the Aurignacean-upper Parigordean culture. If so, its date (found astronomically) would be *c*. 19,000 B. C. as shown above.

The upper limit of the date

The upper limit of the date can be computed as follows :

The figure seeks to depict that the cusp of the moon which is just visible above the Eastern horizon along with the first magnitute star Pollux. According to the injunction of the great matriarch (depicted in the figure), it would be the festive day of autumn — the day of thanksgiving. In India, it is even today the beginning of Devipaksha — the beginning of autumn festival with the Goddess as the presiding deity. It inspired the unknown artist, the first great sculptor of the world, to create a faithful permanent record of the great day which he was actually witnessing with its presiding matriarch. The figure of the Mother Goddess of the Laussel caves was about to be born — as the Matriarch solemnly held the sacred horn with its marks in her right hand at the gate of her abode in the sacred cave. It was a solemn moment and we are grateful to the artist who captured that moment and preserved it for postertity.

Speaking astronomically, the figure symbolically represents the heliacal rising of the last visible phase of the moon (at the end of the thirteenth night) along with the star Pollux *at the autumnal equinox.*

The longitude of the star Pollux is 112.88° (Base year = 1970 A. D.)

To find the upper limit of the age, we have to find the maximum distance of the star Pollux from the sun at which this phenomenon would occur.

The usual distance of the first magnitude star rising heliacally with the moon would be about 12° from the sun. The maximum distance would be 26;° beyond this diṣtance it would no longer be the thirteenth night but the twelfth night. Hence, the position of the sun at this maximum distance would be about 138° (112.88°+25°)

The position of the sun at the vernal equinox in 1970 A. D. — 0°

∴ the precession is —138°(1)

However, it has been already pointed out that due adjustment should be made for the 180° phase shift for the Aurignacean — upper Perigordian age. Taking this into account, the total precession works out to 318° (138°+180°),

Hence the time elapsed since the epoch = 318 × 72 years
= 22,896 years
∴ the epoch of the observation = 20,926 B. C.
say,
= 21,000 B. C.

This is the first approximation, taking the rate of precession to be 72 years per degree. Obviously, a finer calculation is unnecessary because of the grossness of the original observation.)

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(1) The star Pollux is called Punar-Vasu r e. Vasu *again*. Was it originally (i. e. in c. 19000 B.C.) only Vasu ? Who knows ? It is indeed curious that the longitude of Vasu (=B - Delphinis) is 316°: This remarkable coincidence must be fortuitous.

The lower limit has been already found to be *c*. 19,000 B. C.

Hence we can, with some confidence, say that the probable date of the statue of the mother goddess at Laussel is c. 20,000 (± 1,000) B. C.

ii The sorcerer of the Les Trois Frere caves

One of the most important figures in the Megdellanean cave paintings is the figure known as the 'Sorcerer' in the Le Trois Frere caves of france being painted in a remote inaccessible portion thereof, called the Ṣanctuary. It is a composite figure of a human being of which the head is that of an antelope. It may be that there is only a mask with an antelope's head. It is particularly important to note that the figure is painted in a rather inaccessible portion of the cave and it is generally agreed that it was used for some esoteric ritual. The figure, therefore, has some magical or esoteric significance. What was possibly the magic ?

We agree with Leyman and Le Roi Gourham that it represents some key object in the cave man's symbolism and would suggest that *it was a figure marking the onset of a season and would suggest further that it marked summer or winter solstice.*

It has been already shown that the Stag's head (or the Antelope's head) marked the star L-*Orionis* : This has been ascertained from the remote traditions carried in the Rigveda and the Vedic astronomy. In the Vedas, the star was called the *Mrigashiras* which literally meant the 'stag's head' or the 'antelope's head'.

The seasons were marked as follows :

4100 B. C.	Autumnal equinox at the full moon at Stag's head : Spring equinox at the new moon at the Stag's head.
10,700 B. C.	Summer solstice at the full moon at the Stag's head : Winter solstice at the new moon at the Stag's head.

The figure is definitely known to be Magdellanean i. e., it lies in the range say, 14,000 B. C. to 8,000 B. C. It is suggested therefore, that it marked the winter solstice — a great day in the Ice Age of Europe. Further, it is astronomically computed to 10,600 B. C. Alternatively, if the date is taken as given, then, the phenomenon is suggested as the likely esoteric significance of the dance, with which the sorcerer induced the season.

Finally, attention is again invited to the hymn R. V. 1.164; it specifically says that the mystic Word exists in four planes of which THREE ARE DEPOSITED IN SECRET CAVES.

III) Aswin — an ancient Indo-European god

One of the most important gods of the Rigveda is the pair-Aswins. : They are also called Aswa-yujau. Aswini literally means today-'rider of horses'. And, Aswa-yujau would mean one who has harnessed (or saddled) the horse : or, rather, one who has harnessed a pair of them. Or, the pair of gods, who harnessed the first horse.

This meaning is assumed today because the Sanskrit 'Aswa' means (from *circa* 2,500 B. C. onwards) 'horse'. Functionally, the Aswin is the dawn god, who indicates the advent of the dawn *even from the midnight.* Astronomically, Aswin is the star β - Arietis (Long 33°). As long ago as *c.* 1,400 B. C., the celebrated etymologist Yaska said that they were perhaps "deified hero-kings (Nir. 6.1.1) according to the historians—defied for their special meritorious work."

Now, ASWA in the original Indo-European did not mean a horse *but an ass.* For instance, in Polish, we have :

ASWA - OSI'O (Polish); Pronounced OS O (U), meaning an ass. (I am indebted to my Polish friend Prof. Byrsky, who is also a scholar of Sanskrit, for this very interesting piece of information).

One would now see that the Sankskrit word (Ashwa) was not related originally to the horse at all but, if at all, it was related phonetically to the word ASS. Working further, we see indeed that in the Rigveda 1.116.2, the Aswins are said to ride an ass. In R. V. 1.34.9, it is said that the chariot of the Aswin is drawn by a pair of asses.

The word *ashwa* meant a horse in *circa* 2,500 B. C., when the the composition of the Vedic hymns began with the advent of Viswamitra I. Prior to that, probably in the Indo-European period, the word Aswa meant an ass. The new word RASHABHA is used to denote an ass by Kakshivana and Hiranyastupa Angirasa, say in 2,000 B. C. or later.

Yaska writing in c. 1,400 B. C., suggested that Aswins were perhaps hero-kings who were deified for their noble deeds. It seems that they were the heroes who first harnessed the ass-like horses roaming over the European and the Asian plains in the prehistoric times, some 10,000 years B.P. They were deified for this memorable act.

Deification usually takes place when the hero-king is dead i. e. when he goes to the heavens. Since time immemorial, dead men are associated with the stars. Thus, a hero is first made a god, and then, when he ascends to the heavens, he is associated with a star. The formula Hero-God-Star, will explain many Vedic phenomena (It was first suggested by G. S. Basu, in his *Purana-Pravesha;* we wholly agree with this illuminating suggestion.) It is noteworthy that in the legends and myths of the gods of every country, a god is always associated with a star—and the bright stars are generally associated with some god-hero or other. Aswin for instance, is associated with the star β Arietis (Long. 33.5°).

We are now ready to turn to the astronomy and the chronology of the Aswins.

According to Yaska, (1,400 B. C.), the Aswins are the dawn gods, marking the advent of dawn even at mid-night (Nirukta)

To understand this myth properly, we have to transport ourselves to the high latitudes (say 60°), the intensely cold regions of Northern Europe and Asia. For, Aswins are the earliest instance of deification, which must have taken place when the Aryans (I use the term 'Aryans' in the absence of any better) lived together in Europe i. e. when the core of the Indo-European languages developed somewhere in Europe. We may ultimately have to go to the Cromagnards who lived some 40,000 years ago for the birth of that *spraach* but, for the present, we need go back only about 10,000 B. P., when the ice-cap finally receded after the fourth glacial Wisconsin-Valders final sub-phase, and the Magdellanean cave dwellers finally spread out.

In Northern Europe and Asia, in latitudes of 60° and higher, where slavonic languages now prevail, the winter was then long and dark. It was very cold. Every one looked to the day of the winter solstice when the sun would turn North. The astronomers would know the date even though the sun itself was not visible. This was the great day, for the spring would now come. We may compare the winter with the night, the dawn with the spring and the day with the summer. In the Vedic myths, they say that in the lands of the Devas, there is a day of six months and a night of six months. A finer comparison would be — dawn with the spring equinox; and winter solstice with the midnight. This led Tilak to propound the theory of the Arctic home of the vedas. One need not go that far,but some of the Vedic traditions, particularly those relating to the Aswins and dawn, would be better understood only if we transplant ourselves mentally, to latitudes 60° and higher.

In those lands, Aswins - the star β-Arietis would be the god of winter solstice in *circa* 7000 B. C.

Astronomically, the heliacal rising of β-Arietis (or, what the same thing, the new moon at the star β-Arietis) would mark the winter solstice in *circa* 7000 B. C.; the divine midnight, when this event occurs, the equnox is only three moons away. The exact

date when the star Arietis was 270° from the point of spring equinox was 6,906 B. C. This date is of some importance in chronology, because we postulate that at about this time,

a. The ice cap melted in hrigh latitudes of about 60°.

b. The cave dwellers spread out.

c. The ass-like horses were tamed or harnessed.

d. The hero-kings who did this remarkable feat also made some kind of triangular car or sledge to which these asses were harnessed.

These hero kings were deified. They were placed as *the stars of the solstice,* the highest honour that could be bestowed upon man.

> This star (marking the solstice) was β-Arieties (Long 33.5°)

Shorn of the legends, therefore, the Aswin would be the hero-king who tamed the ass-like horses (the 'onagars' of the Altemira and Lasceaux cave paintings) in *circa* 7,000 B. C. For this memorable great act, they were deified and identified with the main star-god of the times.

These pot bellied ass-like horses have been painted in the Magdellanean caves all over Europe (*see* e. g. Lasceaux cave paintings.) in the period 15,000 — 10,000 B. P. However, in these cave paintings, they are not yet harnessed, saddled or tamed. There is no picture where there is a rider over any horse: none in which it draws a chariot or other conveyance. They were perhaps harnessed (saddled i. e. *aswa-yuja*) later i. e. *after* the days of cave paintings; perhaps when the ice cap finally receded after the fourth glacial Wisconsin-Valders final sub-phase, and the cave dwellers finally spread out. Usually, this (viz., the end of the Wurm glacial) is dated to 10,000 B. P., but recently, De Geers has dated this epoch by 'advance' method to 6,839 B. C. (See Wheeler : New Techniques in Astronomy Archaeology, *p. 386).*

This tally, (viz., 6,906 B. C. as the astronomical epoch of the winter solstice at B-Arietis, and De Geer's determination of 6,839 B. C. by advance method) is, of course, fortuitous; however, it is clear that the agreement is within the margin of tolerance. (In the astronomical method, the margin of error is ± 700 years, assuming an error of ten days in marking the solstice.)

What is of importance to note is that in applying the astronomical methods to periods prior to 6,000 B. C., the worker should keep the quarter-phase shift (of 6,500 years each) carefully in view :

For instance, with Aswins (B—Arietis) itself, we have

Heliacal rising at Arietis	*circa*	
Spring/equinox	500 B. C.	
Winter solstice	7,000 B. C.	
Autumnal equinox	13,500 B. C.	Megdelanean period
Summer solstice	20,000 B. C.	Upper Perigordean ,,
Spring equinox	26,500 B. C.	Aurignacean ,,

The epoch of c. 7000 B. C. is, therefore, taken as the probable date of the taming of the horse-like asses and the deification of those hero-kings who achieved this superhuman task.

Conclusion

An attempt has been made in these pages to find out the dates of the prehistoric cave paintings and figures, on the basis of certain astronomical assumptions viz. that even in those remote ages, the human brain and mind was sufficiently developed, as is also shown by the artistic paintings and figures themselves. They used certain bright stars and used the full moon or the new moon thereat, to mark the onset of seasons and their annual festivals. On this interpretation, the results are :

i.	Perigordian Mother Goddess at the Laussel cave	$= 20{,}000 \pm 1000$ B. C
ii.	Sorcerer of the Sanctuary at Les Trois Frere	$10{,}600 \pm 1000$ B. C.
iii.	Harnessing of ass-like horses	$7{,}000 \pm 700$ B. C.

The dates have been arrived at on the basis of certain traditions preserved in the Rigveda. The dates suggest that the hymns belonged to a race whose distant ancestors painted the caves. In other words, the pre-history of the distant ancestors of the Vedic seers goes back to

the days European cave art. Were they the distant descendants of the Cromagnon people : who will answer ?

Lest it be mistaken, it is reiterated that Dirghatamas, the composer of the hymn R. V. 1.164, belonged to only c. 2400 B. C. The only unusual submission is that this remarkable hymn contains the wisdom and tradition coming down from the very dawn of the awakening of the Human mind. The hymn obviously calls for a careful examination and this will be done elsewhere.

The hymn shows that the distant ancestors of the Vedic people once - in the distant past - lived in Europe. It would be shown in due course that the mystery of the stonehenges which are known to be 'sun-temples' or prehistoric astronomical observatories, can also be partly solved by this hymn. This hymn is indeed a veritable storehouse of ancient wisdom and tradition.

This hymn *inter alia* suggests an explanation to the curious fact first noticed by Sir William Jones viz. the family-likeness of the distant Indian and the European *spraach*. The proposed explanation/interpretation substantiates *inter alia*, the existence of one common language and explains the genesis of the common roots and structure of the Indo-European family of speech and languages. Only, the origin goes back to about 10,000 B. P., instead 1500 B. C. as Max Muller thought.

Appendix

Vedic Science

Dirghatama and the Rigvedic hymn 1.164

The Rigvedic hymn 1.164 by Dirghatama is an encyclopedic compendium of Vedic knowledge and wisdom as well as of traditions coming from the very dawn of human awakening.

1. Dirghatama, the poet

A colourful personality, Dirghatama, the composer of this wonderful hymn, had also the appelations Mamateya (son of Mamata, the mother) and Aucathya (son of Ucathya, the father). Belonging to the family of Bharadwajas, he also had his enemies, because a number of stories are told about his birth and life, evidently concocted by his jealous enemies.

Dirghatama consecrated Bharata, the son of Dushanta, who was a contemporary of King Sargon (Sar-u-khin) of Akkad, because having the dynastic number of 43, Bharata was born in 2,411 B. C. Dirghatama was elder than him and according to the dynastic chronology was born in c. 2447 B. C. He lived up to more than ten yugas i. e. more than 90 years.

Dirghatama and his contemporary rishi Vishwamitra II, established the autumn star at Krittika [1] (Alcyon = long.

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(1) Autum star means the star which signifies autumn. In the scientific and exact astronomical sense — there was autumal equinox, when the moon was full at the star. A full moon near the autum star was also near the autumnal equinox, and, for the Vedic people, it was the day of festivities. Agni (= Krittika or Alcyon) was the child god, because he was made the god of time just then.

59.5°), whose Vedic name was *AGNI* (2) Consequently, they all must have lived in c. 2350 B. C. (see R. V. 1.164.11)

Dirghatama's hymn 1.162 gives an elaborate, verbatim and eye witness account of an Ashwamedha sacrifice; it is quite probable that it was THE Ashwamedha of Bharata and was the beginning of the elaborate ritual which was considered to be a characteristic achievement of a powerful Vedic sovereign.

Thus, Purnima at Agni would mean a purnima near Alcyon. It is quite possible that some of the nakshatra names Krittika, Amba Dula were taken over from the Huriyupeans just then (c. 2350 B. C.)

The hymn is an eulogy on the cosmic time-wheel. The spoked wheel was known to Dirghatamas and indeed he described it scientifically, fully analysing the motion. The Russian workers have sought to identify the well known six-spoked wheel of the Harappan seals of this period (c. 2300 B. C.) with the *SHADARA CHAKRA* (six spoked wheel) mentioned in this very hymn R. V. 1.164.12)

2. Vedic interpretation

The ancient Indians (of c. 1400 B. C.) sought to give many and varied interpretations of the Vedic hymns. Thus, Yaska sanctioned

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(2) According to Colebrooke, a star was designated by its presiding deity, particularly if it was NOT a true year (*samvatsara* or a 'perfect' i e. an inte:-calated year). Thus, *Indra* signified Jyeshtha Rohini (Antares); Prajapati signified Rohini (Aldebaran); Soma signified Mrigashiras (L Orionis); Rudra signified (Betelguse), and so on. This explains the total abscnce of the nakshatra names in the Rigveda, although there are many astronomical and calendrical references therein. An example will be given in the present essay itself (1.164.11)

Colebrooke explained the matter thus :

"In several passages of the Jyotisha, these names of tha deities are used for constellations over which they preside; especially the one, which states the situation of the moon, when the sun reaches the tropic, *in years other then the first of the cycle*. Everywhere these terms are explained, as indicating the constellations which the enumeration allots them. Texts, contained in the Vedas themselves, confirm the correspondence; and the connection of Ashwini and the Ashwins is indeed decisive"

inter alia, the historical (or *aitihasika*) interpretation. He also specifically talks of three planes in which the gods live : *dyu-sthana* of heavens (i. e. heavenly or astronomical); *antariksha-sthana* (or atmospherical i. e. seasonal) and *prithivi-sthana* (i. e. terrestrial). The Taittiriya Upanishad broadly sanctions three types of meanings viz. *adhi-daivika, adhi-bhautika* and *adhi-atmika*. (vide T. Up. 1.3; Kena Up. 44)

Adhi-daivika interpretation relates to the Devas or shining heavenly beings. It means heavenly, cosmic, celestial interpretation or, speaking scientifically, gives astronomical significance thereof : It has been shown that the word *deva* means luminaries of the celestial sphere who regulate and mark time, under the provenance of a cosmic law (Ritam of the Vedic people) whose discovery sparked off the Vedic science itself (for details, see Part I *supra*), where it has been shown that the god-groups Vishwedevas, Vasus, and Rudras were the earliest pristine devas, each group marking a separate system of intercalation).

Adhi-bhautika relates to the visible earth and its atmosphere, primarily to the seasons which, significantly enough, is called Ritu-a word derived from the same root RIT.

Adhi-atmika means intra-personal because the word *Atma* originally meant *'Persona'* Including the body itself, the mind and the spirit. Significantly again, the key word is Ritu or the female menstruation, which is also intimately related to the lunar synodic month.

The grand discovery of the Mother Goddess Aditi was that the same law embedded in the root word RIT, governed phenomna of the heavens, phenomena of seasons and phenomena of a female body (See Current Anthropology, Oct 1973. pp. 436.)

The peculiarity of the earliest Upanishads is that they seek to give all the interpretation simultaneously to the same hymn, because in the Upanishads, the concept of Atman is expanded to contain the entire cosmos : The cosmos and the body is permeated by

ONE SOUL which is not only personal but cosmic as well. This concept sharply distinguishes the Indian *welt-anschauung* from all other philosophies and life-views. Interestingly enough, this very hymn of Dirghatama led to this interesting realisation and, therefore, its philosophical significance is also immense.

In the present hymn of Dirghatama, all the three kinds of knowledge are present. In the present essay, however only some astronomical hymns will be selected and considered in detail. Along with the theories and observations on astronomy, the hymn gives the theory of the cosmic wheel which has been aptly called the COSMIC TIME WHEEL. The hymn gives not only the scientific (i. e., the geometric) theory of the circle but also the theory of the revolving wheel i. e., of circular motion in which the laws of simple harmonic motion are explicit. (Why have the laws of the circular motion been given the honorific title of HARMONIC motion ?)

Further, only the scientific (i. e. the astronomical, mathematical, geometrical and physical) theories of Dirghatama alone will now be analysed. It will be shown that the great Ptolemy was acquainted with this astronomical hymn.

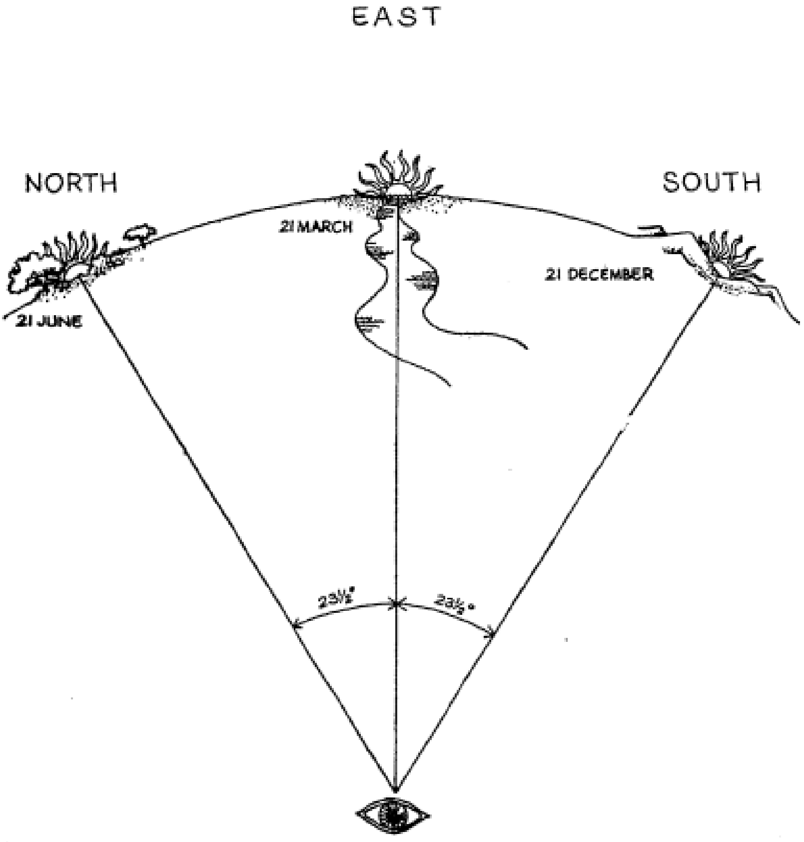
The relevant hymns *(riks)* will now be given in detail. For the original riks, their paraphrase in sanskrit (*anwaya*), and different English translations please see the commentories by Wilson, Griffiths and Whitney which may be conveniently read now by those who are unacquainted with them. The hymns and their analyses now follow :

3. Analysis of the hymns :

R. V. 1.164.1

Translation : "I behold the Lord (= *vispati*) with seven sons. His middle brother is the stone monolith (= *ashna*) and the third brother is *ghritaprishtha*. He is benign and eld grey haired."

This is a description of sunrises (daily, monthly and yearly) in an observatory not unlike the stonehenges of Western Europe. It is a description of the annual swings of the sun northwards and



ANNUAL SWINGS OF THE SUN
(AT THE EQUATOR)

southwards but the particular observation that is described was made on the equinox day when *the sun rose exactly due East* (see the hymn no. 11 *infra)*

Before proceeding further, it is very necessary to tell the readers that it will be presently shown that Dirghatama's date was c. 2350 B. C. and, at about this time, the Druid stonehenges of England were in active operation for observational purposes. Druids are supposed to have some connection with the Aryans, and Wadell once thought that Aryans lived there. It is, of course, *not* suggested that Dirghatama or Viswamitra II worked in the stonehenges of England because such stone-henges existed all over the ancient world. It is only submitted that there is no anachronism in the interpretation proposed. It should also be remembered that the Russians workers have suggested that the Harappans got the idea of the spoked wheel from the Aryans, and this very hymn describes the six spoked wheel (*shad-ara cakra* : 1.164.12). Harappa flourished in 2350 B. C. and thus there is no anachronism in the proposed interpretation.

The middle brother was the middle monolith of the observatory (or some distant stone marker on the horizon) which marked the East point. This stone indicator marked the midmost sun i.e., the autumnal or the vernal sun. The third brother was seen in the summer when the back was full of sweat *(Ghrita prishtha)*. The seven sons were the seven stones which marked the twelve monthly positions of the sun at sunrise.

The seven markers are unequally placed somewhat as follows :—

●	●	●	●	●	●	●
1	2	3	4	5	6	7
A	B	C	D	E	F	G
			MAR.	APR.	MAY.	JUN.
DEC.	NOV.	OCT.	SEP.	AUG.	JUL.	JUN.
DEC.	JAN.	FEB.	MAR.			

The seven unequally spaced markers are A, B, C, D, E, F, G, are the seven sons of the Lord (= *Vispati*). The midmost brother is D, while the third brother is G, the summer sun. For the mathematical meaning, see hymns 3 & 5 *infra*.

R. V. 1.164.2 : Further elaborating the seven markers, the poet describes the cosmic time-wheel.

"They yoke the seven horses in the one wheeled car; one horse, named seven, bears it along; the three naved wheel is undecaying, never loosened, and in it abide the regions of the universe".

Thus, it is explained that the seven are merely the seven names of the same ONE. (see also the great 46th hymn establishing monotheism.)

Dirghatama now describes his *ratham-eka-cakram* i.e. the one wheeled car : It is the great cosmic wheel, the universe itself being conceived as one giant wheel which is incessantly revolving since the beginning of the beginning (*cf:* the galaxies and the milky way which are also like giant wheels). The cosmic wheel has three naves which phrase has a double meaning. The simpler meaning is that it indicates three different rates of rotation — diurnal (of the stars), monthly (of the moon), and yearly (of the sun). The deeper meaning is that it is trying to indicate three axes of revolution of free motion.

A Vedic mantra is like a mathematical formula : One formula can be applied to diverse phenomena. Thus, the simple formula $y = A \sin (wt)$ can describe a pendulum, an atom, a pulsating quaser, a point on a rotating wheel as well as many other diverse phenomena.

The cosmic wheel is also the WHEEL of TIME. It is the cosmic TIME-WHEEL, a kind of space-time complex which is different from the space-time continuum of Einstein. An abstract mathematical analysis of Dirghatama's ideas is possible, but it would take one too far away from the main subject of today.

R. V. 1.164.3. : "The seven who preside over the seven wheeled chariot are the seven horses who draw it. Seven sisters ride it together and in it are deposited the seven *gavam.*"

R. V. 1.164.5. : "Immature in understanding and undiscerning in mind am I, who is eager to know. *I enquire of those things which* are hidden even from the gods : (what are) the seven threads *(*or chords) which the sages have woven round the sun in which all abide?"

Here, the seven threads (or chords) and the wheel represent a mathematical model. In modern jargon, it is an analog computer or a simulator but we prefer the simple term viz a 'mathematical model'. It is trying to analyse the motion of a nail fixed on the rim of a rotating wheel, which is being observed from a point outside the wheel but lying in the same plane. In brief, it is a model of a simple harmonic analyser of first degree. (Remember the formula $Y = A \sin (wt)$, which describes the motion?)

The seven unequally spaced stones simulate the value of the seven fundamental sines viz.,

$\sin 0° = 0 : \sin \pm 90° = \pm 1. : \sin \pm 30° = \pm 1/2 : \sin \pm 60° = \pm\sqrt{3}/2.$

And, in terms of the seven markers :

1. $A = -1.$
2. $B = -\sqrt{3}/2$
3. $C = -1/2$
4. $D = 0$
5. $E = +1/2$
6. $F = +\sqrt{3}/2$
7. $G = +1.$

This was the initial approach to the analysis of sines giving only SEVEN values. In course of time, it was further and further redfine

by bisecting, and again bisecting, till the Siddhanta system of TWENTYFOUR sines (*tribhagasesha* or 1/4 of a fortnight) was reached. However, a discussion of the development of the Indian theory of sines from Dirghatama to Suryasiddhanta is not the subject of the present study.

It need hardly be pointed out that the actual mathematical or the arithmetical values were *not* calculated by Dirghatama. His model only gave the relative sizes of these values : just as is done in the simulators.

In the contemporary Harappan seals (c. 2400 B. C.), one finds the six spoked wheel as well as the seven sisters mentioned in the hymn.

R. V. 1.164.11 : "The twelve spoked wheel of Ritam revolves incessantly, round the heavens. It is undecaying. Children of fire (Agni) 720 in pairs, abide therein."

How can Fire (= Agni) have 720 children ? The riddle is solved as follows :—

Here Agni does not mean fire but *Krittika* of which Agni is the presiding deity. 360 pairs (= 720) of day-nights abide in the year which begins at the Krittika full moon. Hence, they are the children of 'fire'!!

The hymn *conclusively* shows that Dirghatamas established the new years' day — the beginning of the ritual cycle — at Krittika full moon : Obviously, it was the dawn of the autumnal equinox when the sun rose exactly due East, because that was the day of the middle brother (the middle monolith of the stonehenge-like observatory), when Dirghatamas especially worshipped as the HOTU — the divine celestial invoker (1) —in the very first hymn.

(1) Hotu, Invoker who initiates the cycle of good works of the year.

From this observation, the epoch of Dirghatamas can be easily computed :

Agni = Krittika
= Alcyon
= Long 59.5°

Hence, the precession is about 60°

Consequently, the period elapsed @ one degree per 72 years is about 4320 years, from the base year 1970 A.D.

∴ the epoch = 2350 B. C.

It should be carefully noted that any refinement in computation is pointless. This is so because the observation would be approximate — correct to say, three days, three dyus (tithis) or three degrees, which means an error margin of about ± 200 years.

Thus, Dirghatamas established the autumn star at Alcyon in the epoch 2350±200 B. C.

1.164.48 "The fellies are twelve; the wheel is one; there are three axles; but who knows it ? Within it are collected 360 (spokes) which contain all that moves and all that stands still."

The geometry of the circle : The wheel is divided into twelve sectors and 360 finer subdivisions. Hence, it is for the first time, when the division of the circle into 360 divisions (degrees) is conceived; for, Dirghatama worked in c. 2350 B. C. and no earlier theory is known.

Why twelve and three hundred and sixty ? Because it is the WHEEL OF TIME.

The Vedic seers (in particular, Dirghatama and his coworker Viswamitra II) used twelve full moons (*masas*) to define a year which was looked upon as the period in which the seasons recurred. The great discovery of the Vedic rishika Aditi was that a *season recurred when the full moon came back to the same star.* The invariable,

inviolable connection between the full moon at a particular nakshatra and a particular season (*ritu*) was called the cosmic RITAM and entire Rigveda is an eulogy to this grand cosmic law. Astronomically, twelve full moons define a synodic year : each division (twelfth part of the time wheel) was called a *masa* or *purnamasa* from which the word PURIMA was itself derived. Of course, after three yeare, one extra lunar month was needed to bring the full moon back to the same nakshatra — the autumn star : but the analysis of this process of intercalation was completed by Viswamitra in his grand rik (R. V. 3.9.9) (see A. I., p. 137-140).

Each month was completed in about 30 days (sometimes 30 and sometimes 29 — all the ancient people knew that a season takes 59 days). Hence, the Vedic people conceived the idea of a DYU, and defined it as the thirtieth part of a *masa* (i.e. synodic month). This unit of time (viz. the thirtieth part of a synodic month) still continues and is now called a *tithi*. Thus, a *tithi* is the same unit of time as was then conceived in the Vedic word *dyu*. One meets the word *tithi* in the Rigveda in the form of the word *a-tithi* i.e. a guest who stays for a *tithi*. The words *dyu* and *tithi* occurs in R. V. The word Dyu is found not only in the Rigveda itself in an astronomical sense, (e.g. R. V. 4.33.7) but in later literature as well, e.g. Ved jyot: 12; 31; 37; 39; Suryasiddhanta : 1.36.

The true year was obtained from a synodic year by means of visual intercalation (see below). Great injustice was done to the history of Indian astronomy by European scholars (who had no idea of lunar time reckoning) by summarily declaring that a Vedic year was made up of 360 *days* instead of 360 *dyus*. The European having no concept of the power and depth of lunar measurement, hastily declared that the Vedic people were unscientific and crude observers. Even the great Neugebauer is not free from this charge of haste and summary criticism because it is clear from Dirghatama's hymn that the Vedic Aryans discovered the difference between a day and a *dyu* in *c.* 2350 B. C. i.e. about 1500 years before even the rudiments of Chaldean astronomy began. In fact, Neugebauer defines exact scientific astronomy only on a solar time

base and, therefore, his analysis is singularly unsuitable for understanding the Vedic system.

It should be particularly noticed that Dirghatama conceived of the wheel of Law (*ritasya cakram* 1.164.11 *supra*) as the TIME-WHEEL. In Indian Vedic astronomy, the sun and moon are taken to revolve with uniform angular motions (velocities). These motions averaged out over long periods, and the period of synods (i.e. the length of a synodic month) was evolved more and more accurately over a long period of years. The value of a lunar synodic month determined in Indian astronomy is surprisingly accurate, correct to the hundredth part of a second :

Surya siddhanta *masa*	=	29.530588	days.
Modern *masa*	=	29.530588	days.
S. S. *tithi*	=	.984352933..	day.
Modern *tithi*	=	.984352933...	day.

This accuracy is not fortutious but is the result of observations spread over millennea. In astronomy, accuracy is attained either by fine instruments or by observations spreading over centuries. In fact, we are *now* (in 1975 A. D.) trying to find the change in the diurnal motion of the earth by reference to the solar eclipse of Atri-Swarbhanu. An example of how it was actually done by the Vedic people will now be given.

Originally, the year was taken to be 12 full moons i.e. 360 dyus or about 354 days. This was discarded by Aditi even in prehistory, when she introduced an intercalation (visual or observational) in the third year viz. an extra month in the third year, which meant a three-year period of 37 months instead of 36 months.

3 years	=	37 months
	=	37 X 30 dyus
∴ One year	=	370 dyus
	=	about 364 days

Viswamitra conceived a *theoretical* period of 30 years in which one further month was needed. Thus, a thirty year yuga was made up of eleven extra months, instead of ten extra months. Viswamitra's thirty years were made up of 371 months (360 months *plus* 11 extra months)

30 years	=	371 months
	=	371 X 30 dyus
∴ One year	=	371 dyus
	=	365.19 days

There are reasons to believe that Dirghatama hinted at SEVEN intercalary months (Seven sisters paying homage to SEVEN gavam of specific years). This he did, by combining a the *Vasava* system (8 year yuga with 3 extra months) with a *Raudra* system (11 year yuga with 4 extra months) and, thus arriving at a 19 year scheme with seven intercalary months, yielding a year of 371 1/19 dyus i.e. a Metonic year of 365.24 days. However, a fuller investigation of this thesis will lead us too far away.

Thus, Viswamitra determined a year of 371 dyus or 365.19 days 365.1949 days as against 365.2564 days of modern astronomy, a fantastic achievement for 2350 B. C., by any standard. Viswamitra expressed the result in a remarkable hymn RV 3.9.9. where he worshipped 3339 devas (371 X 9) beginning with Krittika (Agni).

It is apparent now that Dirghatama's hymn and Viswamitra's hymn not only show the use of a decimal system, but also establishes the use of a decimal system in full bloom (12, 360, 371, 3339, 33, 11 - all used in an exact astronomical context). In fact, soon afterwards, in the Taittiriya samhita one comes across not only with a full elaboration of a *nakshatra* system of 27 stars beginning with *Krittika* (Alcyon) but also with a number system going up to a *parardha* (= 1,000,000,000,000). This number was obviously required and used in astronomy,

However, one must not confuse a decimal system with a decimal notation or decimal script, as has been hitherto done. A DECIMAL

SYSTEM DOES NOT NECESSARILY REQUIRE A SCRIPT OR WRITTEN NOTATION. Vedic people used cups (called *kapalas*) and beads (called *akshas*) for calculation and manipulation of numbers. I have actually used the Vedic method to multiply a number of six digits with a number of six digits in about 2 minutes. Warren, in his Kalasmkalita, describes the system in active operation.

In fact, *aksha sutras* (a kind of kippu script and language) were nemonics of a very high order and it also served the purpose of 'recorders' or 'registers' of modern computing machines. Calculi were actually used for calculations. Incidentally, this explains why the *aksha-ṣutra* (=a string of beads) is the chief emblem of Saraswati, the Vedic goddess of learning.

An important and almost crucial feature should now be noticed. Dirghatama defined a time wheel and measured the *dyus (tithis)*. He DID NOT DEFINE ANGLES AS SUCH. Thus, in Vedic astronomy, with its concept of uniform average rate of revolution of the sun and the moon (therefore, of uniform differential rate thereof), the basic object of measurement was time in tithis but not angles. By measuring tithis, one could get the angles (the angular distances between the sun and the moon, and, therefore, indirectly, between the stars). Thus, four tithis mean that the distance between the sun and the moon is 48 degrees. By measuring angles, time is measured today but for the Vedic observers it was the other way about : To them, time defined the (angular) distance. There is a cosmic clock and there are twenty seven marks on it. If you can read it, you can not only correct your chronometer, but also measure the angles. If you cannot, then take the help of Dirghatama's wheel and you will unravel the mysteries hidden even from the gods (R. V. 1.164.5). For instance, by studying the shift of the autumn stars, Viswamitra discovered that the season advanced by one Vasu in 3339 parivatsaras; giving a rate of 72 years per degree. Is it not a mystery of the highest order.

I do not think that one will get the archaeological remains of

a Vedic observatory, because the Vedic people measured time : not angles.

This is particularly so, because the Vedic observer was not required to foretell the future of his king from the hour to hour position of the planets. He was required to predict the monthly synods for the religious rites. His astronomy was for months, years and yugas. As centuries and then millennea elapsed, the Vedic synodic month improved. They indirectly measured angles *via* time up to *tribhaga-shesha* of a *paksha* (one fourth of a half month), and prepared a sine table of 24 values. But the system had its limitations. From and after 500 B. C., Indian astronomy languished because of Buddha's stern prohibition in Magadha, the home of Indian astronomy, whereas the Chaldean astronomy improved beyond recognition. However, we need not consider the subsequent development but concentrate on Dirghatama's astronomy.

General

Some general observations are necessary before closing. The hymn is of "unprecedented length" says Wilson. It has 52 stanzas and, as said above, it is the repository of ancient wisdom. For instance, the theory of prosody is contained in the stanzas 23-25; the theory of the dual soul (the mortal earthly soul and the divine cosmic soul — the worm and the god in man) in stanzas 20—22; the theory of the creative LOGOS (Vak or the Word of ST. John can be traced to this hymn) in stanzas 41—42; the theory of Monotheism and Monism in stanza 46, and so on. Ancient knowledge (i. e. knowledge already ancient in Dirghatama's time) is spread throughout the hymn.

The hymn has been badly mauled in the hands of fhe commentators (both ancient and modern), because no commentator was prepared to admit that he has not grasped the hymn that he was interpreting. (I frankly admit that most of the hymns are beyond me.) It has to be very carefully approached to reveal its true depth because it contains very ancient thoughts (thoughts which became ancient even wnen it was composed in c. 2350 B. C.) coming down

from the very dawn of human civilization. Thus, take the rik 45 : Wilson translates : "Four are the definite grades of speech; those Brahmanas who are wise know them : three deposited in secret indicate no meaning; men speak of the fourth grade of speech".

I would prefer to use the direct word 'cave' instead of the figurative word 'secret' for the original word *guha*. I would also keep the original word Vak (= LOGOS) instead of speech. The rik would then be rendered thus :

"Four are the grades of Vak (Logos/Wisdom/speech/creative power). Only Brahmanas (the knower of Brahma — the real meaning which is power e. g. as in $E = m c^2$) knows them fully. They are deposited in (secret) caves and do not explain themselves. Only the fourth (ordinary speech) is spoken and understood by man".

Following this clue it is possible to break the code of the Sorcerer of Les Trois Frere caves of Southern France, and to show that it was alive in c. 11,000 B. C.

The hymn R. V. 1.164 is indeed a gold mine of anthropology and ethnology which will amply reward investigation in depth.

The Coup de grace

It was conjectured by Weber that Asura Maya of the Surya Siddhanta was Ptolemy, the Alexandrian Greek astronomer because the name was called Tura Maya in the contemporaneous Pali records of India. It is further said that the great astronomer Ptolemy taught the Solar astronomy (Surya Siddhanta) to the Indians.

I agree with this view because the Surya Siddhanta was composed towards the end of the Krita, which comes to about (138—186) A.D. (vide A. I. p. 138) The synchronism is, therefore, perfect, because Ptolemy worked in the period 150-200 A.D.

However, if this conjecture is accepted then it would mean that there was contact between Alexandrian Greeks and the Indians in the period. This is, of course, not surprising because the

Greeks had already made extensive contacts with India from Alexander's time. Be that as it may, is there any definite evidence of exchange of astronomical ideas between Ptolemy and the Indians? There is.

A sublime hymn of Dirghatama is the hymn R. V. 1.164.39 where he gives the cosmic grandeur of the science of astronomy. Wilson translates the *rik* as follows : "All the gods have taken their seats upon this supreme heaven, the imperishable text of the Veda : What will he, who knows not this, do with the Veda? but they who do know this, they are perfect."

I would prefer a more literal and more direct rendering :

"39. "The riks are written in the high heavens, where the Vishwedevas sit in high assembly. What shall he do with these (earthly) riks, he who cannot read those heavenly ones? but he who knows them, (i.e. the heavenly riks,) sit and enjoy with them (the gods)"

(Note : Vishwedevas were the primal gods of intercalaction, 33 in number. They demarcated time vide p. 22, *supra*.)

Ptolemy adopted this grand philosophy and gave it out in his celebrated epigram : (*vide* Ancient Science and Modern Civilization by Sarton, p. 43)

"I know that I am mortal and ephemeral, but when I scan the circling spirals of the stars, I no longer touch the earth with my feet, but side by side with Zeus, I take my fill of Ambrosia, the food of the gods". Greek Anthology (IX, 577)

This is the best rendering so far (modenn or ancient), of the spirit of Dirghatama's hymn and, no wonder, because an astronomer of the status of Dirghatama can only be apprehended by an astronomer of the stamp of Ptolemy. Please remember that the language of astronomy is different from the language of philosophy, just as the language of physics is altogether different from the language of literature, although both may be written in English language and in

English script. A philologist will be a poor vehicle for understanding Dirghatama, unless he takes pains to learn astronomy and the method of looking up at the stars.

This leads to an important corollary. The loftiest hymns of the Rigveda (and they are indeed few — I have seen only half a dozen so far) depict nature : the reality and the laws of nature ; they represent the loftiest thoughts of mankind. They can be compared only with the abstract mathematical laws of modern physics and dynamics (like the Einstein equation $E = mc^2$; Newton equation $F = \frac{Gmxm'}{x^2}$; or, of the simple harmonic motion $y = A \sin (wt)$.

They are the eternal laws of the universe — seen by the scientist in his inspiration. Some of the *riks* similarly represent the highest vision. These *riks* reveal the eternal and immutable laws of nature, the simple pristine picture of reality. They exist in the universe itself from the beginning of the beginning, and the seer sees them.

The 'seer' sees them. Dirghatamas saw them : Ptolemy saw them : Viswamitra saw them : Einstein saw them : Dirac saw them : And, very recently, Watson and Crick saw them, the pair of snakes which contain the mystery of life. They are written in the highest heavens and in the innermost depths of reality[1]. They were written in the beginning of the beginning, when TIME itself was created. What shall he do with earthly *riks*, he who has not seen those heavenly ones ?

CENTRAL ARCHAEOLO... New Delhi

(1) It is in this sense that the *riks* are said to be eternal, and it is in this sense that Yajnavalkya said (Br. U. 2.4.10) that the *riks* were created with the creation itself. The chronologist merely fixes the date of the seer and the date of observation or the date of the discovery or *the date of the uncovering of the truth.*

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Further reading

1. Baity's compreoensive review article : Archaeoastronomy and ethnoaestronomy so far, *Current Anthropology*, Oct., 1973. pp. 389-449.

2. Roy, Chronological Infrastructure of Indian Protohistory, 3100-600 B C. JBRS, Vol LVIII, 1972, pp 44-78

3. Roy, Vedic Chronology, JAHS, Vol XXXIII, p. 75.
4. Roy, Harappan Chronology, an integrated study, Purattatva, Vol. 7, p. 75.

and

5. Roy, Ancient India, a chronological study, 1500-400 B.C.

Idam nama purvajebhyah purvebhyah pathikridbhyah :

R. V. X - 14 : 5

With salutations to all those seers who have found a path for us.

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Astronomy.

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